Total No. of Questions : 8]

SEAT No. :

P1433

[Total No. of Pages :3

[5222] - 101

M.Sc.

PHYSICS

PHYUT- 501 : Classical Mechanics

(Semester - I) (2013 Pattern) (5 Credits) (Credit System)

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

Instructions to the candidates:

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

Q1) a) Prove that the period of rotation of the plane of oscillation of Foucault's pendulum is given by $T = \frac{2\pi}{\omega \sin\lambda}$ **[4]**

b) Using virial theorem show that the relation between kinetic energy (T) & potential energy (V) for inverse square law forces is given by $2T + V = 0$ **[3]**

c) Lagrangian for one dimension harmonic oscillator is given by $L = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}kx^2$, obtain corresponding Hamiltonian. **[3]**

Q2) a) Prove that $[t, H] = 1$ **[4]**

b) $Q = aq + bp$, $P = cq + dp$, the given transformation is canonical if $ad - bc = 1$ **[3]**

c) Homogencity of space leads to conservation of linear momentum. Justify. **[3]**

P.T.O.

Q3) a) State & prove Poisson's theorem. **[4]**

b) Explain the effect of Coriolis force on

i) rivers

ii) projectile **[3]**

c) Show that for a particle moving through inverse square law forces, areal velocity remains constant. **[3]**

Q4) a) Obtain Hamiltonian for simple pendulum oscillating in x-y plane. Show that period of simple pendulum is given by $T = 2\pi\sqrt{l/g}$ **[4]**

b) Check canonicality of given transformation $Q = \sqrt{2q}\, e^{t} \cos p \;\; P = \sqrt{2q}\, e^{-t} \sin p$ **[3]**

c) Show that Lagrangian, for a two body problem reduced to an equivalent one body problem, is given by $L = \frac{1}{2}\mu\dot{r}^2 - v(r)$ **[3]**

Q5) a) Show that Hamilton's equations can be expressed in terms of Poisson's bracket as $\dot{q}_i = [H, q_i]$ & $\dot{p}_i = [H, p_i]$. **[4]**

b) Draw phase space & state space for one dimensional harmonic oscillator. **[3]**

c) Give the classification of constraints. **[3]**

Q6) a) A particle of mass m is released from rest in a uniform field of force $\vec{F} = m\vec{g}$. Find the path for which time taken by the particle to move from point 1 to point 2 (in a plane) will be minimum. **[4]**

b) Prove that total energy of a particle moving through central forces is a constant of motion. **[3]**

c) State any two gyroscopic forces. Prove that gyroscopic forces doesn't consume power. **[3]**

Q7) a) Obtain an Hamiltonian for a relativistic free particle. **[5]**

b) If $Q = \log\left[\frac{\sin p}{q}\right]$ $P = q \cot p$ & $H = \frac{p^2}{2m} + \frac{Kq^2}{2}$ find $F_1(q, Q, t)$ & K(Q, P, t) **[5]**

Q8) a) Prove that total energy for a scleronomic system with no nonpotential forces remain constant. **[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]**

& & &

Total No. of Questions : 8]

SEAT No. :

P1434

[Total No. of Pages : 2

[5222]-102
M.Sc.
PHYSICS
PHY UT - 502 : Electronics
(2013 Pattern) (Semester - I) (5-Credits)

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

Instructions to the candidates:

1) ***Solve any <u>FIVE</u> questions out of the following eight questions.***
2) ***Neat diagrams must be drawn whenever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Explain IC 555 as Astable multivibrator. Also give the necessary timing diagram. **[4]**

b) What is PLL? Explain it's capture & lock in range. **[3]**

c) Explain thermal shuntdown, state two important features of 78XX voltage regulator. **[3]**

Q2) a) With the help of necessary circuit diagram explain R-2R ladder type converter. Discuss the advantages & disadvantages of binary type & R-2R type converter. **[4]**

b) State the principle of SMPS; Explain its advantages. **[3]**

c) Place on the truth table and map the function.

$R = A\bar{B}\bar{C}D + A\bar{B}C\bar{D} + \bar{A}BCD$ and obtain reduced expression. **[3]**

Q3) a) With neat diagram explain DC-DC converter. **[4]**

b) Explain FM demodulator using PLL IC 565. **[3]**

c) What is voltage follower? Draw its circuit diagram using op-Amp and explain its working. **[3]**

Q4) a) Explain the operation of Dual Slope ADC. **[4]**

b) Define the following terms used for op-Amp. **[3]**

P.T.O.

i) Open loop gain

ii) Input offset voltage

iii) Input offset current

c) Draw circuit diagram of low quality 1st order Band pass filter. Derive expression for it's cutoff frequencies. **[3]**

Q5) a) What is foldback current dimiting? Draw the circuit diagram for foldback powersupply using IC723 and explain it's operation. **[4]**

b) Draw the functional block diagram of IC7495 state it's applications. **[3]**

c) Draw circuit diagram of half-wave precision rectifier. Explain it's working. **[3]**

Q6) a) Derive the expression for T = 0.69 Rc for monostable multivibrator using op-Amp. **[4]**

b) Explain synchronous and Asynchronous 3-bit counter in detail. **[3]**

c) Explain in detail block diagram of IC 7490. State its applications. **[3]**

Q7) a) Design Astable multivibrator using IC 555 for the following values.

duty cycle = 75%

Frequency = 650Hz, capacitor = 0.1 μF and hence draw Astable multivibrator circuit diagram showing proper component values. **[5]**

b) Design basic low voltage regulator using IC 723 for the following data.

V_0 = +5V, current through(R_1 + R_2) = I = 1 mA. Limiting Current (I_c) = 100 mA. **[5]**

Q8) a) Design combinational logic circuit which produces high output when binary input is equivalent to 0,2,3,6,7,10,11,14,15. **[5]**

b) Design a circuit to implement following expression.

$V_{out} = -3(2V_1 + 4V_2 + V_3)$ **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

SEAT No. :

P1435

[Total No. of Pages : 3

[5222] - 103

M.Sc.

PHYSICS

PHYUT503 : Mathematical Methods in Physics

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

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

Instructions to the candidates:

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

Q1) a) Determine Laguerre polynomials $L_0(x)$, $L_1(x)$ and $L_2(x)$ by using Rodrigue's formula. **[4]**

b) Show that the vectors $u_1 = (1, 1, 1)$, $u_2 = (1, 2, 3)$, $u_3 = (1, 5, 8)$ span R^3. **[3]**

c) Find $L\{F(t)\}$ if $F(t)=\begin{cases}5 & 0<t<3\\ 0 & t>3\end{cases}$. **[3]**

Q2) a) What is analytic function? Show that $\left(\frac{d}{dz}\right)\overline{z}$ does not exist any where? **[4]**

b) Let $A=\begin{bmatrix}4 & 1 & -1\\ 2 & 5 & -2\\ 1 & 1 & 2\end{bmatrix}$. Find all eigen values of A. **[3]**

c) Find the Fourier cosine transform of $f(x) = e^{-2x} + 4e^{-3x}$. **[3]**

P.T.O.

Q3) a) State and prove Cauchy-Schwartz inequality for inner product space. **[4]**

b) Prove the recurrence relation for Legendre polynomial $P'_{n+1}(x)+P'_{n-1}(x)=2xP'_n(x)+P_n(x)$. **[3]**

c) Prove that $u = e^{-x}(x\sin y - y\cos y)$ is harmonic. **[3]**

Q4) a) What is subspace of vector space? Show that W is subspace of $V = R^3$ where W consists of those vectors each whose sum of component is zero. **[4]**

b) For Bessel function of the first kind show that $J'_n(x)=\frac{1}{2}\left[J_{n-1}(x)-J_{n+1}(x)\right]$. **[3]**

c) Define dimension of vector space. find the dimension of subspace W of R^4 spanned by (1, 4, –1, 3), (2, 1, –3, –1) and (0, 2, 1, –5). **[3]**

Q5) a) Show that $\int_0^{\infty}\frac{\cos\alpha x}{\alpha^2+1}d\alpha=\frac{\pi}{2}e^{-x}$, $x\geq 0$. **[4]**

b) Evaluate $\oint_C \frac{5z^2-3z+2}{(z-1)^3}dz$ where C is any simple closed curve enclosing $z = 1$. **[3]**

c) Define Fourier series. Determine the Fourier coefficients for even functions. **[3]**

Q6) a) Find the Fourier coefficients corresponding to the function $f(x)=\begin{cases}0 & -5<x<0\\ 3 & 0<x<5\end{cases}$ and write corresponding Fourier Series. **[4]**

b) Prove the recurrence relation for Hermite polynomials

$H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$. **[3]**

c) Determine whether or not u and v are linearly dependent where :

$u = 2t^2 + 4t - 3$, $v = 4t^2 + 8t - 6$. **[3]**

Q7) a) Evaluate the integral $\int_C \frac{5z-2}{z(z-1)}dz$ when C is the circle $|z|=2$ described counter clockwise. **[5]**

b) For Bessel function of the first kind show that $J_n(x) = (-1)^n J_n(-x)$. **[5]**

Q8) a) Solve $y'' + 9y = \cos 2t$ if $y(0) = 1$, $y\left(\frac{\pi}{2}\right) = -1$. **[5]**

b) State and prove the convolution theorem for Fourier transform. **[5]**

Total No. of Questions :8]

SEAT No. :

P1436

[Total No. of Pages : 2

[5222]-104
M.Sc.
PHYSICS
PHYUT - 504 : Atoms Molecules and 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 labelled diagrams wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use fo logarithmic table and electronic calculator is allowed.***

Given:

1) ***Rest mass of electron = 9.109×10^{-31} kg***
2) ***Charge on electron = 1.6021×10^{-19} coulomb.***
3) ***Plank's constant = 6.626×10^{-34} Js.***
4) ***Boltzman constant = $1.38054 \times 10^{-23} JK^{-1}$***
5) ***Avogadro's number = 9.27×10^{-24} amp-m^2.***
6) ***1 eV = 1.6021×10^{-19} J.***

Q1) a) Draw block diagram of ESR spectrometer and state its basic requirements. **[4]**

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

c) Calculate the energy in (eV) electron volt of a CO_2 laser having wavelength of radiation $\lambda = 10.5 \mu m$ **[3]**

Q2) a) Discuss construction and working of Nd-YAG laser and state its applications. **[4]**

b) The band head of the band is at higher frequency than that of the band origin. What does it imply? **[3]**

c) What is Lande 'g' factor? Calculate it for $^2P_{3/2}$ state. **[3]**

Q3) a) What are the characteristics of laser Light. **[4]**

b) " The intensity distribution of the lines in electronic spectra of molecules is not same" Comment. **[3]**

c) The Zeeman component of a 500 nm spectral lines are 0.0115 nm apart, when magnetic field is 1T. Find the ratio e/m. **[3]**

P.T.O.

Q4) a) Show that threshold condition for lasing is $\gamma^{th} = \alpha_s + \frac{1}{2L} \ln \frac{1}{r_1 r_2}$ where symbols have their usual meaning. **[4]**

b) State Pauli's exclusion principle and write the states of an electrons in Na-atom. **[3]**

c) A gas laser is generating a laser beam of 5 mW power. Calculate the number of photans emitted by the laser. The wavelength of emitted light is 670 nm. **[3]**

Q5) a) Draw block diagram of NMR spectrometer and state its basic requirements. **[4]**

b) Discuss the application of laser in industry. **[3]**

c) The values of X_e and X'_e for lower and upper states of CO are 6.2×10^{-3} and 1.14×10^{-2} respectively. Find the number of vibrational levels for lower and upper states of CO. **[3]**

Q6) a) State and explain Frank-Candon principle. **[4]**

b) Define gyromagnetic ratio. State the relation connecting μ_s and S of an electron. **[3]**

c) Deduce the expression for Einstein's coefficients and state their physical significance. **[3]**

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

b) Explain principle and working of CO_2 laser. State its application. **[5]**

Q8) a) A free electron gives resonance at a frequency of 9.5 GHz when a magnetic field strength is 0.34 T. At what frequency the resonance occurs if the magnetic field is 1.3 T. (g = 2.00 23). **[5]**

b) Explain the normal Zeeman effect on the basis of quantum theory and deduce the expression for shift in wavelength $d\lambda$. **[5]**

Total No. of Questions :8]

SEAT No. :

P1437

[Total No. of Pages :3

[5222] - 201

M.Sc.

PHYSICS

PHY UT - 601: Electrodynamics

(New 2013 Pattern) (5 Credits) (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 logarithmic table and calculator is allowed.***

Q1) a) Derive Faradays law of induction for moving medium. **[4]**

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

c) Explain the term 'Skin Effect' and 'Skin Depth'. **[3]**

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

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

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

P.T.O.

Q3) 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) Write the boundary conditions at the interface of dielectric and explain them. **[3]**

c) Explain the concept of dipole radiation and radiation resistance. **[3]**

Q4) a) Obtain an expression for electromagnetic field tensor $F_{\mu}\gamma$. **[4]**

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

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

Q5) a) Explain the term 'Four Vector Potential'. **[4]**

b) Find the impedance of an e.m. wave travelling through free space.

Given: $\mu_0 = 4\Pi \times 10^{-7} \frac{\mathrm{W}b}{\mathrm{A}-m}$ and $\in_0 = 8.85 \times 10^{12} \frac{C^2}{\mathrm{N}-m^2}$. **[3]**

c) Derive in homogeneous wave equation in terms of scalar potential ϕ and vector potential $\vec{\mathrm{A}}$. **[3]**

Q6) a) A plane e.m. wave is propogating through a stationary medium. Assuming the solution of wave, show that it satisfies the relation $CB_z = E_y$. **[4]**

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

c) Given the e.m. Wave equation:

$\vec{\mathrm{E}} = \hat{i}\, E_0 \cos \omega\left(\sqrt{\in \mu}\, z - t\right) + \hat{\mathrm{j}}\, \mathrm{E}_0 \mathrm{Sin}\, \omega\left(\sqrt{\in \mu}\, z - t\right)$ where E_0 is constant find the corresponding magnetic field. **[3]**

Q7) a) Derive Lorentz relativistic transformation equations. **[5]**

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

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

b) A plane e.m. wave is incident obliquely on an interface between the two non-conducting dielectric media. Obtain an expression for Snell's law. **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

SEAT No. :

P1438

[Total No. of Pages : 3

[5222]-202
M.Sc.
PHYSICS
PHYUT-602 : Solid State Physics
(2013 Pattern) (Semester - II) (5-Credits)

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 tables and calculator is allowed.***

Constants :

Boltzman constant	$= 1.38\times10^{-23}$ Jk^{-1}
Plank's constant	$= 6.623\times10^{-34}$ J-S
Avogadro's number	$= 6.023\times10^{23}(mole)^{-1}$
Mass of electron	$= 9.1\times10^{-31}$ kg
Charge on electron	$= 1.6\times10^{-19}$ C
Bohr magnetron	$= 9.27\times10^{-24}$ $A.m^2$
Permeability of free space	$= 4\pi\times10^{-7}$ Hm^{-1}

Q1) a) Give an account of Weiss theory of Ferromagnetism. Hence deduce Curie-Weiss law. **[4]**

b) Show that for Kroning-Penny potential with $P \ll 1$, the energy of the lowest energy band at K = 0 is $E = \frac{\hbar^2 p}{ma^2}$. **[3]**

c) Distinguish between ferromagnetism and antiferromagnetism. **[3]**

P.T.O.

Q2) a) Derive an expression for effective mass of electron in a crystal. **[4]**

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

c) A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptibility and the magnetization produced in a uniform magnetic field of 10^6 A/m at a room temperature. **[3]**

Q3) a) Explain the reduced zone, extended zone and periodic zone schemes for representing energy bands with neat diagrams. **[4]**

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

c) The density and atomic number of niobium is 8.57×10^3 kg/m^3 and g^3 respectively. It has one electron per atom. Calculate London penetration depth of niobium. **[3]**

Q4) a) Derive an expression for paramagnetic susceptibility using quantum theory of paramagnetism. **[4]**

b) Define the terms **[3]**

i) Critical temperature

ii) Critical field for a superconductor

c) A paramagnetic material has 6.02×10^{28} atoms/m^3 and its Fermi energy is 11.64 eV. Determine Pauli's paramagnetic susceptibility. **[3]**

Q5) a) Explain the formation of energy gap on the basis of nearly free electron model. **[4]**

b) Explain the terms anisotropy energy and Block wall with reference to magnetization. **[3]**

c) Sodium metal with bcc structure has two atoms per unit cell. The radius of sodium atom is 1.95 A°. Estimate the order of diamagnetic susceptibility. **[3]**

Q6) a) What is cyclotron resonance? Obtain an expression for cyclotron frequency of block electrons. **[4]**

b) Explain Meissner effect in super conductor. **[3]**

c) Atomic weight and density of iron are 55.85 and 7.87×10^3 kg/m^3 respectively. If iron has a magnetic moment of 2.4 Bohr magnetron, determine the spontaneous magnetization. **[3]**

Q7) a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. **[5]**

b) Explain the phenomenon of hysteresis and hysteresis curve on the basis of domain theory. **[5]**

Q8) a) Write an expression for Bloch function and discuss it's properties. **[5]**

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

♦ ♦ ♦

Total No. of Questions :8]

SEAT No. :

P1439

[Total No. of Pages : 2

[5222]-203
M.Sc.
PHYSICS
PHY UT - 603 : Experimental Techniques in physics
(2013 Pattern) (5 Credit System) (Semester - II)

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

Instructions to the candidates:

1) ***Boltzmann constant, $K_B = 1.38\times10^{-23}$ J/K.***
2) ***Planck's constant, $h = 6.63\times10^{-34}$ J.s***
3) ***Avogadro's number, $N = 6.023\times10^{23}$/gm.mole.***
4) ***Mass of electron, $Me = 9.1 \times 10^{-31}$ Kg.***
5) ***Velocity of light, $c = 3\times10^{8}$m/s***
6) ***Change of electron, $e = 1.6\times10^{-19}$c.***

Q1) a) Write the electromagnetic radiations with their wavelength range and corresponding energies. **[4]**

b) In an electron microscope , the accelerating voltage is 60KV. Calculate the wavelength in A°. **[3]**

c) Write short note on field applications of vacuum. **[3]**

Q2) a) Explain the principle, construction and working of FTIR spectrometer. **[4]**

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

c) Write a short note on periodic and Random signals. **[3]**

Q3) a) Explain the techniques of production of UV-visible and IR radiations. **[4]**

b) Describe the various types of errors in brief. **[3]**

c) What are the different pumping concepts are used in vaccum pumps? **[3]**

Q4) a) Write a short note on Electron spin Resonance. **[4]**

b) What are auto and cross correlation functions. **[3]**

c) What is Getter? Explain in brief Getterion Pump. **[3]**

P.T.O.

Q5) a) With the help of schematic diagram, explain the basic components of TEM. **[4]**

b) Write a short note on thermal analysis. **[3]**

c) Write short note on time and frequency domain analysis. **[3]**

Q6) a) Describe the basic principle and applications of optical tweezers. **[4]**

b) Write a short note on Vacuum measurement. **[3]**

c) What is throttling process? Explain in brief. **[3]**

Q7) a) Explain the principle, construction and working of scanning Tunnelling Microscope.(STM). **[5]**

b) What are different operating principles used in sensors? Explain with examples. **[5]**

Q8) a) Explain the principle, construction and working of XPS. **[5]**

b) Write a note on different guages. Explain any one in brief. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1440

[Total No. of Pages : 2

[5222]-204

M.Sc.

PHYSICS

PHYUT 604 : Quantum Mechanics - I

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

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 logrithmic tables and electronic calculators is allowed*

Q1) a) Define projection operator pa using expansion postulate. Show that for any function of an operator A we can write.

$$f(\mathrm{A}) = \sum_a f(a)\,\mathrm{P}_a.$$ **[4]**

b) Explain unitary operator. Show that the norm of a state functions do not changes under unitary transformation. **[3]**

c) Discuss the conditions of validity of WKB Approximation. **[3]**

Q2) a) Obtain clebsch - Gordon coefficients by adding the angular momenta of two non - interacting with $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$. **[4]**

b) Show that the momentum operator is Hermitian operator. **[3]**

c) State the four postulates of quantum mechanics. **[3]**

Q3) a) Define the operators a and a^+ for simple harmonic oscillator. Hence obtain the expressions for energy eigen value and eigen functions. **[4]**

b) Show that the pauli spin matrices satisfy the commutation relation $[\sigma^2, \sigma_z]=0$. **[3]**

c) Define adjoint and self adjoint operators. Show that the eigen values of self-adjoint operator are real. **[3]**

P.T.O.

Q4) a) Show that particle in one-dimensional infinite potential well have discrete energy states. **[4]**

b) Explain time independent perturbation theory and obtain first order correction in energy for non- degenerate state. **[3]**

c) Give the physical interpretation of the wave function state the requirements of the wave functions. **[3]**

Q5) a) Apply the variational method to find out ground state energy of hydrogen atom using trial wave functions $\Psi(r) = Ae^{-\alpha r}$, where α is variational parameter. **[4]**

b) Obtain the matrices for J_x and J_y when j = ½; **[3]**

c) Using WKB, approximation, derive Bohr - sommer feld quantization condition. **[3]**

Q6) a) State and explain completeness and closure property of the wave function. **[4]**

b) Obtain eigen values of L^2 and L_z operators. **[3]**

c) Define Hilbert space. Explain norm and scalar product. **[3]**

Q7) a) Using schrö dinger's equation obtain energy eigen values and eigen functions for one dimensional harmonic oscillator. **[5]**

b) Given that $L_{\pm}|l,m\rangle = C^{\pm}_{lm}|l,m\pm1\rangle$, where L_+ and L_- are raising and lowering operators. Respectively and $|l,m\rangle$ are simulteneous eigen states of L^2 and L_z operators. Obtain an expression for $C^{\pm}_{lm}$. **[5]**

Q8) a) State and prove Fermi Golden rule. **[5]**

b) Let S be spin angular momentum operator operating on two states $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ obtain the matrix representation for S_x, S_y, & S_z. **[5]**

✡ ✡ ✡

Total No. of Questions : 8]

SEAT No. :

P1441

[Total No. of Pages : 2

[5222]-1001
M.Sc.
PHYSICS THEORY
PHY UT 501 : Classical Mechanics
(2014 Pattern) (Semester - I) (Credit System) (4 Credits)

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

Instructions to the candidates:

1) ***Attempt 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) Show that the transformation defined by

$$Q = \sqrt{[2p]} \sin Q$$

$$P = \sqrt{[2p]} \cos Q$$

is canonical. **[4]**

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

c) Obtain the equation of motion of a system of two masses, connected by an inextensible string passing over a small smooth pulley. **[3]**

Q2) a) Using variational principle, explain Brachistro chrane problem. **[4]**

b) Show that a function whose poisson bracket with Hamiltonian vanishes is a constant of motion. **[3]**

c) The position of a particle of mass *m* is given by the cartesion co-ordinates (x, y, z) Assuming a potential energy function.

$v = \frac{1}{2} k \left(x^2 + y^2 + z^2\right)$ & a constraint described by the equation $2\dot{x} + 3\dot{y} + 4\dot{z} + 5 = 0$ find the differential equation of motion. **[3]**

P.T.O.

Q3) a) Show that for spherical surfaces, geodesus are great circles. **[4]**

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

c) Prove that [F, Gs] = [F, G]S + G[F, S]. **[3]**

Q4) a) State & prove Jacobi-Poisson theorem. **[4]**

b) Write a note on Larmour precisian. **[3]**

c) Write a note on condition for closure. **[3]**

Q5) a) State & prove Uirial theorem. **[4]**

b) What are cyclic coordinates? Explain with suitable example. **[3]**

c) Show that the Lagrange's bracket is invariant under Canonical transformation. **[3]**

Q6) a) What is Coriolis force? Explain the effect of Coriolis force an **[4]**

i) flow of river &

ii) air flow on the surface of the earth.

b) What are Galilean transformations? **[3]**

c) Describe the Hamiltonian & Hamilton's equation of motion for charged particle in an electro magnetic field. **[3]**

Q7) a) If $[\phi, \psi]$ be the Poissons bracket, then prove that, $\frac{d}{dt}[\phi,\psi]=\left[\frac{d\phi}{dt},\psi\right]+\left[\phi,\frac{d\psi}{dt}\right]$. **[5]**

b) What is Focaults pendulum? Obtain an equation of motion for such pendulum. **[5]**

Q8) a) A curve passing through two end points (x_1, y_1) & (x_2, y_2) has been rotated about y axis. Find a curve which an revolving about a certain axis forms geometry of minimum surface area. **[5]**

b) State and prove theorem on total energy. **[5]**

★ ★ ★

Total No. of Questions : 8]

SEAT No. :

P1442

[Total No. of Pages : 2

[5222]-1002
M.Sc.
PHYSICS
PHYUT - 502 : Electronics
(2014 Pattern) (Semester - I) (4-Credits)

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

Instructions to the candidates:

1) ***Solve any five questions out of the following 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) Draw the circuit diagram and waveform of IC555 as monostable multivibrator. Explain it's operation. **[4]**

b) Explain the internal block diagram of a 3-pin voltage regulator and explain its working. **[3]**

c) Explain with a neat diagram the working of a 3-bit serial up-down counter. **[3]**

Q2) a) What is foldback current limiting? Draw a circuit diagram of foldback power supply using IC723. Explain it's operation. **[4]**

b) Draw the circuit diagram of an Astable multivibrator using OPAMP and explain it's operation. **[3]**

c) Realize the following expression using basic logic gates.

$$Y = \left(\overline{AB} + \overline{A+B}\right)\overline{AB}$$ **[3]**

Q3) a) Give the circuit diagram of shift register using IC 7495 to explain SIOP and PIPO operation. **[4]**

b) Give the circuit diagram for R-2R ladder type DAC and explain. **[3]**

c) Draw the circuit diagram of DC-DC converter. Explain it's operation. **[3]**

P.T.O.

Q4) a) Give the internal circuit diagram for decade counter using IC 7490 and explain it's working. **[4]**

b) Draw a neat circuit diagram of voltage regulator power supply using discrete components and explain. **[3]**

c) Design monostable multivibrator using IC 741. Use the following specifications. $V_{cc} = \pm$ 15V, V_o = 12V and T = 1 µs. **[3]**

Q5) a) What is PLL? Draw the neat functional block diagram of PLL-IC 565 and explain each block. **[4]**

b) Discuss the working of a successive approximation type ADC. **[3]**

c) What are advantages and disadvantages of SMPS over foldback power supply. **[3]**

Q6) a) How capacitor 'C', charges in voltage controlled oscillator using IC 566? Find the output frequency with following data

V^+= 10V, V_c = 8V, R_1 = 10kΩ and C_1 = 0.1µF. **[4]**

b) Minimize the following Boolean expression using K-map and realize it using the basic gates. Y = Σm(1,2,9,10,11,14,15) **[3]**

c) Design the voltage regulator for output voltage 15V using LM317. [Assume V_{in} = 20V and R_1 = 240Ω] **[3]**

Q7) a) Calculate output frequency f_o, lock range Δf; and capture range Δf_c of a PLL, if R_T = 1kΩ, C_T = 0.1µF and filter capacitor C = 10µF. **[5]**

b) What is K-map? Using 4 input variables that has a high output for an input of 0000, and low output for 0001 to 1001and don't care for 1010 to 1111. What is the simplest logic circuit for these outputs? **[5]**

Q8) a) Design an astable multivibrator using IC 555 for an output frequency 5KHz and duty cycle 40%. **[5]**

b) Explain 2-bit simultaneous A/D converter with logic diagram and give its comparator output for an input voltage range. **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

SEAT No. :

P1443

[Total No. of Pages : 3

[5222] - 1003

M.Sc.

PHYSICS

PHYUT-503 : Mathematical Methods in Physics

(2014 Pattern) (4 - Credit) (Semester - I)

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

Instructions to the candidates:

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

Q1) a) Obtain the Fourier series expansion of $f(x) = x^2$ in $-\pi < x < \pi$. **[4]**

b) Prove the recurrence relation for Bessel function of first kind

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

c) The set S = $\{e^{3t}, te^{3t}, t^2e^{3t}\}$ is a basis of a vector space V of functions $f:R\to R$. Let D be the differential operator on V, i.e. $D(f)=\frac{df}{dt}$.

Find the matrix representation of D relative to the basis S. **[3]**

Q2) a) Let $A=\begin{bmatrix}4 & 1 & -1\\ 2 & 5 & -2\\ 1 & 1 & 2\end{bmatrix}$ **[4]**

i) Find all eigen values of A.

ii) Find a maximum set S of linearly independent eigenvectors of A.

iii) Is A diagonalizable? If yes, find P such that $D = P^{-1}AP$ is diagonal.

P.T.O.

b) The function f(x) is represented as

$$f(x)=\begin{cases}-k & -\pi < x < 0 \\ \mathrm{K} & 0 < x < \pi\end{cases}$$

Find the Fourier coefficient b_n. **[3]**

c) For Legendre polynomial show that $P_n(x) = (-1)^n P_n(x)$. **[3]**

Q3) a) Let $F = R^2 \rightarrow R^2$ be the linear operator defined by $F(x, 4) = (2x + 3y, 4x - 5y)$. Find the matrix representation of F relative to the basis.

$S = \{u_1, u_2\} = \{(1, 2), (2, 5)\}$ **[4]**

b) Suppose the vectors u, v, w are linearly independent. Show that the vectors $u + v$, $u - v$, $u - 2v + w$ are also linearly independent. **[3]**

c) Determine whether or not the vectors $u_1 = (1, 1, 1)$, $u_2 = (1, 2, 3)$, $u_3 = (2, -1, 1)$ from a basis of R^3. **[3]**

Q4) a) Write the generating function for Hermite Polynomial and prove the recurrence relation $H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$. **[4]**

b) Show that the vectors $u_1 = (1, 1, 1)$, $u_2 = (1, 2, 3)$, $u_3 = (1, 5, 8)$ span R^3. **[3]**

c) Show that the functions $f(t) = e^t$, $g(t) = \sin t$, $h(t) = t^2$ are linearly independent. **[3]**

Q5) a) Determine Laguerre polynomials $L_0(x)$ and $L_2(x)$ by using Rodrigue's formula. **[4]**

b) Express $u = (2, -5, 3)$ in R^3 as a linear combination of the vectors.

$u_1 = (1, -3, 2)$, $u_2 = (2, -4, -1)$, $u_3 = (1, -5, 7)$ **[3]**

c) Show that the Fourier sine transform of e^{-at} is $g_s(w)=\sqrt{\frac{2}{\pi}}\cdot\frac{w}{w^2+a^2}$. **[3]**

Q6) a) Write down the Rodrigue's formula for Hermite Polynomials and determine the first three polynomials $H_0(x), H_1(x), H_2(x)$. **[4]**

b) Let T be the linear operator on R^2 defined by $T(x, y) = (4x - 2y, 2x + y)$. Compute the matrix of T in the basis $\{f_1 = (1, 1), f_2 = (-1, 0)\}$. **[3]**

c) Find the characteristics polynomial $\Delta(t)$ of each of the following matrices

$$A=\begin{bmatrix}2 & 5\\ 4 & 1\end{bmatrix},\ B=\begin{bmatrix}7 & -3\\ 5 & -2\end{bmatrix},\ C=\begin{bmatrix}3 & -2\\ 9 & -3\end{bmatrix}.$$ **[3]**

Q7) a) Consider the vector space $p(t)$ with inner product $\langle f, g\rangle = \int_0^1 f(t)g(t)dt$.

Apply the Gram-Schmidt algorithm to the set $\{1, t, t^2\}$ to obtain an orthogonal set $\{f_0, f_1, f_2\}$ with integer coefficients. **[5]**

b) Using Laplace transform, solve the differential equation $y'' - 3y' + 2y = 1 - 4x + 2x^2$ using $y(0) = 4,\ y'(0) = 5$. **[5]**

Q8) a) Express the function

$$f(x)=\begin{cases}1 & \text{when } |x|<1\\ 0 & |x|>1\end{cases}$$

as a Fourier integral. Hence evaluate $\int_0^\infty \frac{\sin w \cos wx}{w} dw$. **[5]**

b) Solve following simultaneous differential equations by using Laplace's transformation

$$\frac{dx}{dt} - y = e^t$$

$$\frac{dy}{dt} + x = \sin t$$

Given : $x(0) = 1, y(0) = 0$. **[5]**

Total No. of Questions :8]

SEAT No. :

P1444

[Total No. of Pages : 2

[5222]-1004
M.Sc.
PHYSICS
PHYUT - 504 : Atoms and Molecules
(2014 Pattern) (4- Credit) (Semester - I)

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

Instructions to the candidates:

1) ***Solve 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 scientific calculator is allowed.***

Given:

1) ***Rest mass of electron = 9.901×10^{-31} kg***
2) ***Charge on electron = 1.602×10^{-19} coulomb.***
3) ***Plank's constant = 6.626×10^{-34} Js.***
4) ***Boltzman constant = 1.38054×10^{-23} J/K***
5) ***Avogadro's number = 6.023×10^{26} atoms/K mole***
6) ***1 eV = 1.602×10^{-19} J.***

Q1) a) List the basic requirements of a typical NMR spectrometer. **[4]**

b) Find the term value of the PP electron configuration assuming L.S coupling. **[3]**

c) What is of factor? Calculate it for $^3D_{5/2}$ term. **[3]**

Q2) a) State and explain Paschen - Back effect for 2s -2p transition. **[4]**

b) Explain the information derived from vibrational analysis of electronic vibration spectra. **[3]**

c) Consider an atom placed in a magnetic field of 1 weber/m^2, which has . $\alpha = 2$. Calculate the rate of precession. **[3]**

Q3) a) Discuss the vibrational modes of 1-D diatomic lattice and explain the origin of optical and acoustic mode. **[4]**

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

P.T.O.

c) A free electron is placed in a magnetic field of strength 1.3 T. Calculate the resonance frequency if g = 2.0023. **[3]**

Q4) a) State and Explain Frank-Condon principle. **[4]**

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

c) The Debye temperature of diamond is 2240 K. Calculate the highest possible Lattice Vibrational frequency. **[3]**

Q5) a) State and explain the principle of ESR? Compare between X-band and Q-band spectrometers. **[4]**

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

c) The value of X_e and X'_e for lower and upper states of C_2 are7.11×10^{-3} and 9.19×10^{-3} respectively. Find the number of vibrational levels in the lower and upper states. **[3]**

Q6) a) Write the points of difference between atomic and moleculer spectra. **[4]**

b) Explain Debye model of lattice heat capacity. **[3]**

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

Q7) a) "In the rotational fine structure of electronic vibration spectra, in certain molecules, the band head appears on the violet side of the spectrum and in certain other molecules the band head appears at the red end of the spectrum" Explain with diagram. **[5]**

b) What is the geometrical structure factor? Derive an expression for GSF of BCC structure. **[5]**

Q8) a) Define atomic scattering factor and show that its maximum value is equal to the atomic number (Z) of the atom. **[5]**

b) Derive an expression for the specific heat of a solid based on Einsten's model. What are the draw-backs of this model. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1445

[Total No. of Pages :2

[5222] - 1005

M.Sc.

PHYSICS

PHYUT - 505 : Experimental Techniques in Physics - I

(Semester - I) (2014 Pattern) (4 - Credits)

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) Derive an expression for pumpdown time. **[4]**

b) Explain through put, impedance and conductance of a vaccum line. **[3]**

c) Explain viscosity and thermal conductivity of gases. **[3]**

Q2) a) Explain the principle, construction and working of oil sealed rotary pump. **[4]**

b) Explain the pumping speed of a vaccum pump. **[3]**

c) Explain flow of gas in the transition range. **[3]**

Q3) a) With neat diagram explain principle, construction and working of cold cathode ionization gauge (penning gauge). **[4]**

b) Discuss the term spectral analysis. **[3]**

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

Q4) a) With neat diagram, explain the constrution of optical tweezers. **[4]**

b) Define the terms : Ultimate pressure and mean free path. **[3]**

P.T.O.

c) Give the vacuum measurement ranges of - **[3]**

i) Piranigauge

ii) Penning gauge and

iii) Triode ionization gauge.

Q5) a) With neat diagram, explain the working of hot-cathode ionization gauge (triode ionization) gauge. **[4]**

b) Determine the average value for the function $y(t) = 30 + 2 \sin 6\pi t$ over the time period 0 to 0.1s. **[3]**

c) Give the properties of fluid used in the diffusion pump. **[3]**

Q6) a) With neat diagram explain Bayard-Alpert ionization gauge. **[4]**

b) Calculate the mean free path of air at ambient temperature with pressure 10×10^{-3} Torr. **[3]**

c) Explain gaseous diffusion. **[3]**

Q7) a) With neat diagram explain principle, construction and working of diffusion pump. **[5]**

b) Calculate the pump down time to reduce the pressure 760 Torr to 10^{-2} Torr if volume of the chamber is 25 lit and pump speed is 50 lit/min. **[5]**

Q8) a) With the help of neat diagram explain the construction and working of molecular dragpump. **[5]**

b) Write the principle of sputter ion pump. **[5]**

Total No. of Questions :8]

SEAT No. :

P1446

[Total No. of Pages :3

[5222] - 2001

M.Sc.

PHYSICS

PHY UT - 601: Electrodynamics

(New 2014 Pattern - 4 Credits) (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 logarithmic tables and pocket calculator is allowed.***

Q1) a) Derive the expression for potential at a distant point using multipole expansion for a localized charge distribution in free - space. **[4]**

b) Show that $(C^2 B^2 – E^2)$ is invariant under Lorentz transformations. **[3]**

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

Q2) a) Obtain an expression for electromagnetic field tensor $F\mu\gamma$. **[4]**

b) Explain the terms ‘Skin effect’ and ‘skin depth’. **[3]**

c) Find the velocity at which the mass of the particle is double it’s rest mass. Given: $C = 3\times10^8$m/s. **[3]**

Q3) a) Derive inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

P.T.O.

b) Write and explain boundary conditions at the interface of two dielectrics. **[3]**

c) Find the phase velocity of a plane e.m. wave at a frequency of 10 GHz in polyethelene material.

Given: $\mu \simeq \mu_0 = 4\Pi \times 10^{-7} \frac{Wb}{\mathrm{A}-m.}$, $\in_r = 2.3$, $\in_o = 8.85 \times 10^{-12} \frac{C^2}{\mathrm{N}-m^2}$

and $\sigma = 2.56 \times 10^{-4}\, mho/m$. **[3]**

Q4) a) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that its curl equals to $\mu_o\, \vec{j}$. **[4]**

b) Write the Maxwell's equations for stationary medium and explain the significance of vacuum displacement current. **[3]**

c) Explain the term 'momentum space' with the help of suitable example. **[3]**

Q5) a) Derive Faraday's law of induction for moving medium. **[4]**

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

c) An electron is accelerated from the rest to a speed of 0.9995 C in a particle accelerator. Determine the total energy of electron, if it's rest mass energy is 8.2×10^{-14} J. **[3]**

Q6) a) A plane e.m. wave is propagated through a stationary medium. Assuming the solution of the wave, show that it satisfies the relation $CB_z = E_y$. **[4]**

b) Explain the term 'Four Vector Potential'. **[3]**

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

Q7) a) With the help of a suitable diagram explain the magnetic interaction between two current loops. **[5]**

b) Draw a neat diagram of Michelson - Morley experiment. Hence derive the formula for fringe shift. **[5]**

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

b) Derive the Lorentz relativistic transformation equations. **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

SEAT No. :

P1447

[Total No. of Pages : 3

[5222]-2002
M.Sc.
PHYSICS
PHY UT - 602 : Solid State Physics
(2014 Pattern) (Semester - II) (4 - Credits)

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 tables and calculator is allowed.***

Constants :

1)	Boltzman constant	K_B	$= 1.38\times10^{-23}$ J/K
2)	Plank's constant	h	$= 6.623\times10^{-34}$ Js
3)	Avogadro's number	N	$= 6.023\times10^{23}$ 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
7)	Bohr magneton	μ_B	$= 9.27\times10^{-24}$ Am^2
8)	Permeability of free space	μ_0	$= 4\pi\times10^{-7}$ H/m
9)	Gas constant	R	= 1.987 cal/mole-K

Q1) a) Use the equation $m\left(\frac{dv}{dt}+\frac{v}{\tau}\right)=-eE$ for the electron drift velocity *v* to show that the dc conductivity of metal is $\sigma = ne^2\tau / m$. Symbols have their usual meanings. **[4]**

b) Differentiate between diamagnetism and paramagnetism. **[3]**

c) The saturation magnetic induction of nickel is 0.65 wb/m^2. If the density of nickel is 8906 kg/m^3 and its atomic weight is 58.7 amu. Calculate the magnetic moment of nickel atom in Bohr magneton. **[3]**

P.T.O.

Q2) a) Derive an expression for diamagnetic susceptibility using langevin theory. **[4]**

b) Explain the concept of anisotropy energy and Bloch wall energy in ferromagnetic material. **[3]**

c) A circular loop of conductor having a diameter of 50 cm carries a current of 100mA. Calculate the value of magnetic dipole moment. **[3]**

Q3) a) With the help of schematic show that the magnetic energy reduces to minimum by dividing the domains in ferromagnetic materials. **[4]**

b) Explain Meissner effect in superconductors. **[3]**

c) Consider a 2-D square lattice of side 0.3nm. At what electron momentum values do the sides of first Brillouin zone come? What is the energy of the free electron with this momentum? **[3]**

Q4) a) Derive London equation for superconducting state and obtain an expression for penetration depth. **[4]**

b) Derive an expression for cyclotron resonance. **[3]**

c) For a specimen V_3 Ga, the critical fields are 1.4×10^5 A/m and 4.2×10^5 A/m for 14k and 13k respectively. Calculate the transition temperature. **[3]**

Q5) a) On the basis of band theory differentiate between metal, semiconductor and insulator. **[4]**

b) Discuss the paramagnetism in rare earth group ions. **[3]**

c) A magnetic material has a magnetization of 3300 A/m and flux density of 0.044 wb/m^2. Calculate the magnetizing force and relative permeability of the material. **[3]**

Q6) a) Derive an expression for paramagnetic susceptibility for the conduction electrons. **[4]**

b) Write a note on ferrites. **[3]**

c) Calculate the critical current density for 1mm diameter wire of lead at 7k.

[Given : T_c for lead is 7.18k and H_0 for Lead is 6.5×10^4 A/m] **[3]**

Q7) a) State Bloch theorem and write the properties of bloch functions. **[5]**

b) Explain the assumptions of BCS theory of superconductors. **[5]**

Q8) a) Derive an expression for paramagnetic susceptibility using Langevin theory. **[5]**

b) Explain ferromagnetism. Derive an expression for Curie-Weiss law from Weiss molecular field theory of ferromagnetism. **[5]**

♦ ♦ ♦

Total No. of Questions :8]

SEAT No. :

P1448

[Total No. of Pages : 3

[5222]-2003
M.Sc.
PHYSICS
PHYUT - 603 : Quantum Mechanics - I
(2014 Pattern) (4 Credits) (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 log tables and calculator allowed.***

Q1) a) Obtain energy eigen values of a particle confined in one dimensional infinite deep potential well. **[4]**

b) Define **[3]**

i) adjoint of an operator $\hat{A}$

ii) Hermitian operator and

Show that $(\hat{A}\,\hat{B})^{+} = \hat{B}^{+}\hat{A}^{+}$.

c) Show that Pauli spin matrices $\sigma_x, \sigma_y, \sigma_z$ are unitary. **[3]**

Q2) a) Define the operators a and a^{+} for harmonic oscillator. Hence obtain the expression for energy eigen value. **[4]**

b) Prove the closure property for orthonormal and complete set of eigen functions. **[3]**

c) Obtain eigen value spectrum of L^2 and L_z operator. **[3]**

Q3) a) Consider a linear operator F and vectors $|\psi\rangle$ and $|x\rangle$ such that $F|\psi\rangle = |x\rangle$ Represent F as a matrix element in A-representation. **[4]**

P.T.O.

b) Let $\hat{S}$ be a spin angular momentum operator acting on two states $x_+ = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $x_- = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Obtain matrix representation for S_x, S_y, S_z. **[3]**

c) The harmonic oscillator is perturbed by $H' = ax^2$. Obtain first order correction in energy in ground state. **[3]**

Q4) a) Obtain Clebsch-Gordan coefficients for a system of two non- interacting particles with angular momenta: $j_1 = \frac{1}{2}, j_2 = \frac{1}{2}$. **[4]**

b) State the conditions of validity of WKB approximation. **[3]**

c) Develop the time-independent perturbation theory to obtain first order correction in energy. **[3]**

Q5) a) Explain unitary transformations. Show that operator equations remain unchanged in form in unitary transformation. **[4]**

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

c) Using expansion postulate, show that eigen functions belonging to continuous eigen values are of infinite norm. **[3]**

Q6) a) Find $< x >, < x^2 >$ and $< p_x >$ in ground state of harmonic oscillator. **[4]**

b) Work out the eigen values and eigen functions of the matrix.

$$H = \begin{bmatrix} 1+\varepsilon & \varepsilon \\ \varepsilon & 1+\varepsilon \end{bmatrix}$$ **[3]**

c) Prove that $\left[x, p^n\right] = ni\hbar\, p^{n-1}$ **[3]**

Q7) a) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$ in the range $-\infty$ to $+\infty$ obtain ground state energy of harmonic oscillator by variational method. Where α is variational parameter. **[5]**

b) Using WKB approximation, obtain the Bohr-Sommerfeld quantization condition. **[5]**

Q8) a) Define norm in Hilbert space and show that in case of unitary operator U Norm $(U|\psi\rangle) = \langle\psi|\psi\rangle$. **[5]**

b) Develop the time dependent perturbation theory to obtain transition amplitude for 1st order. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1449

[Total No. of Pages : 2

[5222] - 2004

M.Sc.

PHYSICS

PHYUT-604 : Lasers

(2014 Pattern) (4 - Credit) (Semester - II)

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

Instructions to the 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 calculators is allowed.***

Q1) a) What are the important properties of laser beam? Explain any two. **[4]**

b) Explain threshold pump power required for laser action. **[3]**

c) The energy difference between two laser levels is 0.117 eV. Determine the wavelength of the radiation. In which spectrum it lies? **[3]**

Q2) a) What do you mean by population inversion? How it can be achieved? **[4]**

b) Calculate the coherence length of a laser beam for which bandwidth $\Delta\nu$ is 3000 Hz. **[3]**

c) Explain the construction and working of Ruby laser. **[3]**

Q3) a) Explain stimulated emission of radiation. What are the important features of stimulated emission? **[4]**

b) Explain the application of laser for eye surgery. **[3]**

c) Calculate the power required for excitation of Ne atoms through resonant transfer of excitation from He to the frequency $\upsilon_p = 4.8\times10^{15}$ Hz corresponding to the second state of He with population $N_2 = 3.4 \times 10^7$ and $\tau_{sp} = 10^{-7}$. **[3]**

P.T.O.

Q4) a) Explain construction and working of Nd-YAG laser. **[4]**

b) State industrial applications of laser and explain any one in brief. **[3]**

c) Write a short note on Nitrogen laser. **[3]**

Q5) a) Explain the use of laser in Holography. How the recording and construction is done? **[4]**

b) For a typical gas laser, the output power is 10^{-3} W at wavelength 500 nm. Calculate :

i) Photon energy of visible light and

ii) Number of photon emitted per second. **[3]**

c) Explain the principle and construction of semiconductor laser. **[3]**

Q6) a) Explain the principle, construction and working of CO_2 laser. **[4]**

b) State significance of Einstein coefficients. **[3]**

c) A gaseous medium gives a laser at infrared wavelength of 3.4 μm. Calculate the difference of energy between upper and lower level.

[Given : $h = 6.63 \times 10^{-34}$ J.S, $C = 3 \times 10^{8}$ m/s] **[3]**

Q7) a) Explain the construction and working of He-Ne laser with energy level diagram. **[5]**

b) The wavelength of emission is 6000Aº and the life time τ_{sp} is 10^{-6} S. Determine the coefficient for the stimulated emission.

[Given : $h = 6.63 \times 10^{-34}$ J.S, $\mu = 1$] **[5]**

Q8) a) Explain three level laser system with energy level diagram. **[5]**

b) Find the relative population inversion of the two states in a ruby laser that produces a light beam of wavelength 6943 Aº at 300 ºK and 500 ºK.

[Given : Boltzman constant $k = 1.38 \times 10^{-23}$ J/K] **[5]**

Total No. of Questions :8]

SEAT No. :

P1450

[Total No. of Pages :2

[5222] - 2005

M.Sc.

PHYSICS

PHY UT - 605: Experimental Techniques in 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 diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarthmic table and calculator is allowed.***

Constants:

1) ***Boltzmann constant*** $K_B = 1.38 \times 10^{-23}$ J/K.
2) ***Plank's Constant*** $h = 6.623 \times 10^{-34}$ Js.
3) ***Avogadro's number*** $N = 6.023 \times 10^{23}$/gm.mole.
4) ***Mass of electron*** $me = 9.1 \times 10^{-31}$ kg.
5) ***Charge on electron*** $e = 1.6 \times 10^{-19}$ C.
6) ***Velocity of light*** $c = 3 \times 10^{8}$m/s.

Q1) a) What does a sensor mean? Discuss the characteristics of sensor. **[4]**

b) In a diffraction experiment using the Cu target (λ=1.54 $\mathring{A}$), the Bragg reflection was observed at $2\theta = 38.3°$. Determine the corresponding interplanar spacing. **[3]**

c) Draw a neat diagram of duel beam spectrometer used in UV - Vis spectroscopic technique. **[3]**

Q2) a) Describe the Laue method used for X-ray diffraction technique. **[4]**

b) Write a short note on Atomic Force Microscopy (AFM). **[3]**

c) Write a short note on working principle involved in nuclear magnetic resonance (NMR) tool. **[3]**

P.T.O.

Q3) a) Discuss the working mechanism of Selected Area Electron Diffraction (SAED) tool. **[4]**

b) Calculate the FWHM for a nano-particle of average size 5 nm, if it has given a Bragg peak at $2\theta = 27^{o}$, when a wavelength of 1.54 $\mathring{A}$ is used in a X - ray diffraction experiment. **[3]**

c) Discuss the working mechanism of a pressure sensor. **[3]**

Q4) a) Discuss the working of Electron Spin Resonance. **[4]**

b) Write a short note on Vibrating Sample Magnetometer (VSM) technique. **[3]**

c) Write a short note on Nuclear detectors. **[3]**

Q5) a) Discuss the factors affecting TGA results. **[4]**

b) Calculate the 'g' value if the methyl radical shows ESR at 3290 G in a spectrometer, operating at 9230 MHz. (Given $\beta = 9.274 \times 10^{-24}$ J/T) **[3]**

c) Write a short note on X-ray detectors. **[3]**

Q6) a) Discuss the working of (a) dielectric and (b) thermal sensors. **[4]**

b) What is Selected Area Electron Diffraction (SAED) technique? **[3]**

c) Draw a block diagram of NMR. **[3]**

Q7) a) Discuss the working of TEM in **[5]**

i) Diffraction and

ii) Imaging Mode.

b) With a suitable diagram, explain the instrumentation for Infra Red spectroscopic technique. **[5]**

Q8) a) Discuss the principle, construction and working of thermo-gravimetric (TGA) technique. **[5]**

b) With a suitable diagram, discuss the construction, principle and working of a Scanning Electron Microscope (SEM). **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

SEAT No. :

P1451

[Total No. of Pages :3

[5222] - 3001

M.Sc.

PHYSICS

PHYUT- 701: Statistical Mechanics in Physics

(Semester - III) (2014 Pattern-4 Credits) (Credit System)

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

Instructions to the candidates:

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

Constants:

1) Boltzmann constant, $k_B = 1.38\times10^{-23}$ J/K
2) Planck's constant, $h = 6.623\times10^{-34}$ J-sec
3) Avogadro's number, $N = 6.023\times10^{23}$/gm-mole
4) Mass of electron, $m_e = 9.1\times10^{-31}$ kg
5) Velocity of light, $c = 3\times10^{8}$ m/s
6) Charge on electron, $e = 1.6\times10^{-19}$ C

Q1) a) Write a note on white dwarf. **[4]**

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

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

Q2) a) Define the terms: **[4]**

i) Phase space

ii) Phase point

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

P.T.O.

c) Consider an ideal monatomic gas of N mole enclosed in volume V. Show that the number of accessible states for energy interval between E and E+ δ E is expressed in the form $\Omega(E) = BV^N E^{3N/2}$, where B is constant independent of E and V. **[3]**

Q3) a) Show that the fluctuation in the number of particles in the system in grand canonical ensemble is given by $\left(\overline{N^2}\right) - \left(\overline{N}\right)^2 = kT\left(\frac{\partial \overline{N}}{\partial \mu}\right)_{v,T}$ **[4]**

b) The equation of motion of classical harmonic oscillator is expressed by $x = a \sin \omega t$. Show that the probability of finding the particle between x & $x+dx$ is given by $P(x)dx = \frac{dx}{\pi\sqrt{a^2 - x^2}}$ **[3]**

c) Write the postulates of equal priori probability. **[3]**

Q4) a) Show that the dispersion in number of particles in the system in grand canonical ensemble is given by $\left(\overline{\Delta N^2}\right) = Z\frac{\partial \overline{N}}{\partial Z}$, where Z is Fugacity, $Z = e^{-\alpha}$ **[4]**

b) Show that entropy in canonical ensemble can be represented as

$$S = -k\sum_r P_r \ln P_r$$ **[3]**

c) A small system has just two states of energy $E_1 = 0J$ and $E_2 = 10^{-22}J$. Assuming Boltzmann distribution, calculate the temperature when the mean energy of the system is $0.5\ E_2$. **[3]**

Q5) a) Calculate mean energy of Fermions at 0°K. Hence write ground state of pressure. **[4]**

b) Two macroscopic system A and A′ are in thermal interaction with each other forming combined system A°, show that a thermal equilibrium is attained by two system. **[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 electron. **[3]**

Q6) a) Prove any two Maxwell's relations of thermodynamics. **[4]**

b) Compare the basic postulates of M-B,B -E and F-D statistics. **[3]**

c) A damped harmonic oscillator is described by the equation $m\frac{d^2x}{dt^2}+R\frac{dx}{dt}+ks=0$. Determine the phase trajectory of the oscillator. **[3]**

Q7) a) Discuss the phenomenon of sharpness of probability distribution in statistical thermodynamics and show that the final width of maximum in P(E) is given by

$$\frac{\Delta^*E}{E}=\frac{1}{\sqrt{f}}$$ **[5]**

b) State equipartition theorem, hence find out mean energy for 1-D, 3-D harmonic oscillator and specific heat of solid. **[5]**

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

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

& & &

Total No. of Questions : 8]

SEAT No. :

P1452

[Total No. of Pages : 5

[5222]-3002
M.Sc.
PHYSICS
PHYUT - 702 : Physics of Semiconductor Devices
(2014 Pattern-4 Credits) (Semester - III)

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

Instructions to the candidates:

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

Q1) a) What is Hall effect? Find the Hall mobility of a semiconducting sample. **[4]**

b) What is meant by the excess carrier? How can we create excess carriers in semiconductor? **[3]**

c) Draw neat labelled diagram of **[3]**

i) Space charge distribution

ii) Electric field distribution and

iii) Potential distribution indicating built in potential, of an abrupt p-n junction in thermal equilibrium.

Q2) a) How to find doping density N from the depletion layer capacitance of one sided abrupt junction at thermal equilibrium. **[4]**

b) With the help of Fick's law, derive Einstein's relations. **[3]**

c) What are the effects of temperature and doping, on the mobility of carriers? **[3]**

Q3) a) Find the equation of diffusion capacitance and conductance at low frequencies. **[4]**

b) What is the role of tunneling and avalanche multiplication in the junction breakdown? **[3]**

c) How to measure the barrier height using I-V characteristics of a metal semiconductor contact? **[3]**

P.T.O.

Q4) a) What is the image force lowering? Derive an expression for image force lowering($\Delta\phi$). **[4]**

b) An abrupt Si p-n junction has Na = 10^{18} cm^{-3} on one side and Nd = 10^{15} cm^{-3} on other. Determine the contact potential (qV_0) of p-n junction at 300K. Given : k = 8.35×10^{-5} eV/K and $n_i = 1.5\times10^{10}$ cm^{-3}. **[3]**

c) What is the second breakdown phenomenon in power transistor? **[3]**

Q5) a) Derive an expression for depletion layer width at thermal equilibrium for one sided abrupt junction. **[4]**

b) Explain the high injection condition under the forward bias state. **[3]**

c) In a very long Si bar with cross sectional area of 0.5 cm^2, the injected excess hole concentration is 5×10^{16} /cm^3 at x = 0. How much excess hole charge is stored in a sample at RT. Given : $L_p = 3.6\times10^{-5}$ cm. **[3]**

Q6) a) Define **[4]**

i) emitter injection efficiency

ii) base transport factor

iii) common-base current gain, and

iv) common emitter current gain of p-n-p transistor

b) What is Krik effect? **[3]**

c) An n-type semiconductor has a minority carrier lifetime of 10^{-6} sec. Find the diffusion length of minority carrier at 300K.

Given : μ_p = 250 cm^2/V.s and kT = 0.0259 V. **[3]**

Q7) a) Derive Shockley diode equation and draw an ideal characteristics of diode. **[5]**

b) Consider a semiconducting bar with width of 0.02 cm, thickness 8 μm, and length of 0.6cm. In Hall measurement, a current of 0.8 mA is passed in the sample and a magnetic field of 10^{-5} Wb/cm^2 is generated at z-direction. If the voltage at the two end is V_{AB} = +1 mV and V_{CD} = 50 mV, then find the type, concentration and mobility of the majority carriers. **[5]**

Q8) a) Find the current density from semiconductor to metal using thermionic emission theory. **[5]**

b) Define Generation, recombination and lifetime of carriers. Draw I-V characteristics of a practical diode indicating

i) Generation recombination current region

ii) Diffusion current region

iii) High injection region and

iv) Series resistance effect and reverse leakage current **[5]**

♦ ♦ ♦

Total No. of Questions : 8]

P1452

[5222]-3002
M.Sc.
PHYSICS
PHYUT - 702 : Quantum Mechanics - II
(2014 Pattern-4 Credits) (Semester - III) (Credit System)

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

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Figures to the right indicate full marks.***
3) ***Use of logarithmic tables and calculators allowed.***

Q1) a) Using trial wave function $\Psi(x) = Ae^{-\alpha x^2}$ in the range $-\infty$ to $+\infty$, estimate ground state energy of linear harmonic oscillator by variational method. (α is variational parameter) **[4]**

b) Discuss selection rules for dipole transitions. **[3]**

c) State and prove optical theorem in scattering. **[3]**

Q2) a) In case of scattering by rigid sphere of radius 'a', show that the scattering cross-section for s-wave is $4\pi a^{2.}$ **[4]**

b) The harmonic oscillator is perturbed by $H^1 = bx^4$. Obtain first order perturbation in energy in the ground state. **[3]**

c) State and explain Pauli's exclusion principle for a system of two identical particles. **[3]**

Q3) a) Obtain slater determinants for N-particle system. **[4]**

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

c) Discuss validity conditions of Born approximation. **[3]**

Q4) a) State and prove Fermi Golden rule. **[4]**

b) Using WKB approximation explain field emission of electrons. **[3]**

c) Discuss space and time translations. **[3]**

Q5) a) Using the potential well discuss Ramsauer and Townsend effect. **[4]**

b) Using spin function, obtain symmetric and anti-symmetric wave functions for system of two electrons. **[3]**

c) Using WKB approximation obtain Bohr quantization condition. **[3]**

Q6) a) Discuss Heisenberg picture in quantum mechanics. **[4]**

b) Discuss the conditions of validity of WKB approximation. **[3]**

c) Discuss centre of mass and laboratory frame of reference with reference to scattering cross-section. **[3]**

Q7) a) Explain in brief time-dependent perturbation theory and obtain expression for first order amplitude $a_n(t)$. **[5]**

b) Using WKB approximation, obtain the transmission probability for barrier potential. **[5]**

Q8) a) Deduce the expression for scattering amplitude using Born Approximation for Yukawa potential. **[5]**

b) Explain Stark effect using time-independent perturbation theory. **[5]**

♦ ♦ ♦

Total No. of Questions :8]

SEAT No. :

P1453

[Total No. of Pages :3

[5222] - 4001

M.Sc.

PHYSICS

PHY UT - 801: Nuclear Physics

(2014 Pattern) (4 Credits) (Semester - IV)

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 tables and pocket calculator is allowed.***

Q1) a) Discuss the collective model of nucleus. **[4]**

b) Describe the types of nuclear reactions. **[3]**

c) Find the activity in curie of 1mg of radon having half life of 3.8 days. **[3]**

Q2) a) Write a note on internal pair creation. **[4]**

b) Discuss the predictions of shell model. **[3]**

c) Calculate K_∞ for a critical reactor employing ^{235}U and graphite in an atom ratio $1:10^5$, Given $\sigma_a = 0.003$ barns for graphite $\sigma_a = 698$ barns for uranium, $\eta = 2.08$ and $\in = 1$ **[3]**

Q3) a) Discuss the theory of microtron. Show that the increase in energy after each orbit is given by $\Delta E = \frac{E_0 \gamma}{\mu - \gamma}$. **[4]**

P.T.O.

b) Define scattering length. Write the expression for it and interpret. **[3]**

c) Calculate the total cross-section for-n-p scattering at neutron energy 2 MeV. Given $a_t = 5.38F$ $a_s = -23.7F$ $r_{rot} = 1.7F$ and $r_{os} = Z.4F$ **[3]**

Q4) a) Write a note on compound nucleus theory. **[4]**

b) Describe the principle and working of cloud chamber detector. **[3]**

c) Which of the reactions are allowed or forbidden under conservation of strangeness, baryon number and charge **[3]**

$\Pi^+ + n \rightarrow \Lambda^o + K^+$

$\Pi^- + P \rightarrow \Lambda^o + K^o$

Q5) a) Explain why experimentally the study of P-P scattering is capable of much higher accuracy than n-p scattering. **[4]**

b) Describe the electron scattering method to determine nuclear size. **[3]**

c) Calculate 'Q'value of the reaction ${}_1^2H(d,n)_2^3He$. Given: **[3]**

$M({}_1^2H = 2.01410V, {}_2^3He = 3.01603V)$

$M_n(1.008665V)$

Q6) a) With a neat diagram explain the principle and working of Si(Li) detector. **[4]**

b) Discuss in details the neutrino hypothesis of β decay **[3]**

c) Find the energy release. If two ${}_1^2H$ nuclei can fuse together to form ${}_2^4He$ nuclear, the B.E. per nucleon of ${}_1^2H$ is1.1 MeV and for ${}_2^4He$ is 2.2 MeV. **[3]**

Q7) a) What are quarks? Do they exists in nature? Explain how quarks are treated as building blocks of hydrons and mesons? **[5]**

b) Describe fermi-gas model and obtain an expression for energy of proton. **[5]**

Q8) a) Describe in details the Geiger - Nuttall Law. **[5]**

b) Explain various conditions for criticability of nuclear reactor. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1454

[Total No. of Pages : 3

[5222]-4002
M.Sc.
PHYSICS
PHY UT - 802 : Materials Science
(2014 Pattern) (Semester - IV) (4 - Credits)

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 tables and calculator is allowed.***

Constants :

Boltzman constant	K_B	$= 1.38\times10^{-23}$ J/K
Avogadro's number	N	$= 6.023\times10^{23}$ gm-mole
Gas constant	R	= 8.314 J/mole-K
Charge on electron	e	$= 1.6\times10^{-19}$ C

Q1) a) Explain how grain boundaries are formed in solids? Also explain the high angle and low angle boundaries. **[4]**

b) Describe the factors governing solid solubility. **[3]**

c) Consider an ideal gas. Show that a gas at high pressure is less disordered than a gas at low pressure under the condition of isothermal expansion.**[3]**

Q2) a) A solid solution contains 97% copper and remaining tin. The FCC unit cell of copper is retained, but expanded a bit because the tin atoms have a radius of approximately 0.151 nm.

i) What is the weight percent(w/o) in 3% tin bronze?

ii) Also calculate the average radius of atoms.

P.T.O.

[Given : Atomic weight of Cu = 63.54 amu

Atomic weight of Sn = 118.69 amu

Radius of Cu atom = 0.1278 nm] **[4]**

b) State and explain Richard's and Trouton's rule. **[3]**

c) Write extension rules of binary phase diagrams. **[3]**

Q3) a) Explain the following thermodynamic functions: Internal energy, Enthalpy, Gibb's Free energy, Entropy. **[4]**

b) With the help of neat diagram explain minima in two-phase regions. **[3]**

c) Calculate enthalpy of formation if the number of vacancies at 312.5 K are three times greater than the number of vacancies at 300K. **[3]**

Q4) a) Describe any one experimental technique for the determination of phase diagram. **[4]**

b) Define the following terms: Hardness, Strength, Toughness **[3]**

c) Describe any one application of diffusion. **[3]**

Q5) a) With the help of neat diagram explain Type I(Lens type) phase diagram. Also write one example. **[4]**

b) Explain interstitial defect in the context of Fe_3C. **[3]**

c) There are 0.19% copper at the surface of aluminium and 0.18% copper, 1.2mm underneath the surface. What will be the flux of copper atoms be from the surface inward at 500ºC per mm^2 per unit time? **[3]**

[Given : A1 is FCC and lattice constant of Al, a = 0.4049 nm Diffusivity $D = 4 \times 10^{-14}$ m^2/s]

Q6) a) Show that Fick's second law leads to Fick's first law under certain condition.Also write the condition. **[4]**

b) Derive an equation for the force present on dislocation. **[3]**

c) Cu-Ni solid solution is known as 'continuous series of solid solution'. Explain. **[3]**

Q7) a) What is dislocation? Distinguish between edge and screw dislocation. **[5]**

b) Derive an expression for Gibb's phase rule. Hence write invariance for unary and binary component system. **[5]**

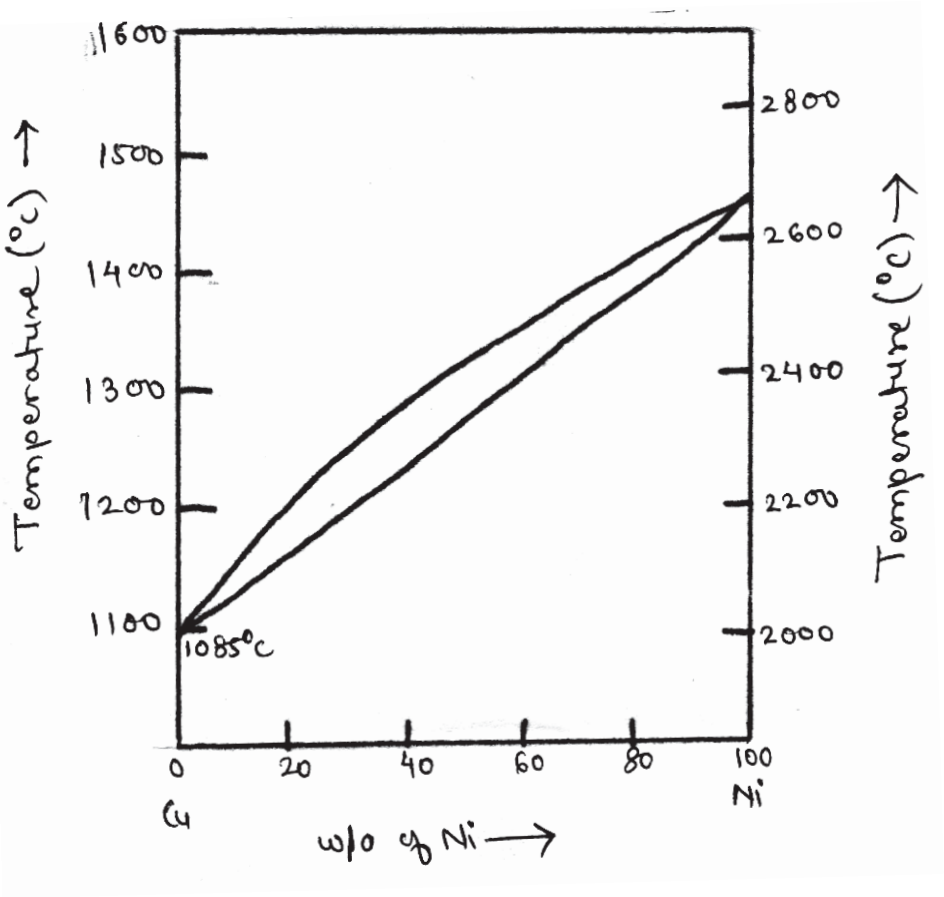
Q8) a) What is diffusion? With the help of neat diagram explain various diffusion mechanisms. **[5]**

b) Consider 65 Cu-35 Ni alloy **[5]**

i) What phase(s) will be present as cooling progresses?

ii) Calculate their compositions using lever rule.

iii) Compare the results.



♦ ♦ ♦