Total No. of Questions :8]

SEAT No. :

P1273

[Total No. of Pages : 2

[5122]-101

M.Sc. (Semester I)

PHYSICS

PHYUT 501 : Classical Mechanics

(2013 Pattern) (Credit System) (5 Credits)

Time : 3 Hour] *[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) If $W = \sum_{i=1}^{n} \vec{F}_i . \vec{r}_i$ is a virial of the system & T is a kinetic energy of the system. Show that under dynamical equilibrium. $2T + W = 0$ **[4]**

b) Prove that momentum corresponding to cyclic coordinate remains constant **[3]**

c) Show that the period of rotation of the plane of oscillation of foucault's pendulum depends upon geographical latitude of the place. **[3]**

Q2) a) Explain how hamilton's equations of motion can be expressed in terms of poisson's bracket **[4]**

b) Check whether the generating function , $F = \sum Qi\,Pi$ leads to an identity transformation or not **[3]**

c) Show that under homogeneity of time total energy of the system remains constant. **[3]**

P.T.O

Q3) a) Show that

$$\frac{d}{dt}[u.v.] = \frac{\partial}{\partial t}[u.v.] + \left[(u.v.)\mathrm{H}\right]$$ **[4]**

b) Prove that work done by coriolis force is zero. **[3]**

c) State & prove kepler's second law **[3]**

Q4) a) Lagrangian for a charged particle moving, relitivistically, through an electromagnetic field is given by . **[4]**

$L(\vec{v},\vec{u}) = -\,moc\sqrt{c^2 - v^2} + e\vec{A}\cdot\vec{V} - e\phi$ obtain corresponding Hamiltonian.

b) $Q = q^{\alpha}\,Cos\beta^{p}$ $P = q^{\alpha}\,sin\beta^{p}$ is canonical only if $\alpha = ½$ & $\beta = 2$. Justify **[3]**

c) Two body problem can be reduced to an equivalent one body problem. Explain in detail the procedure involved. **[3]**

Q5) a) Prove that $[L_x, p_y] = p_z$ **[4]**

b) Give the classification of constraints write the constraint relation for rigid body. **[3]**

c) Consider a simple pendulum oscillating in x - y plane. Draw a configuration space & phase space for given situation **[3]**

Q6) a) Solve the brachistochrone problem. **[4]**

b) Define central force. Show that for a particle moving through central force total angular momentum remains constant. **[3]**

c) Find the period of rotation of the plane of oscillation of foucault's pendulum at

i) North pole ii) equator **[3]**

Q7) a) Prove that poisson's bracket is invariant under canonical transformations. **[5]**

b) Show that geodesics of a sphere is a great circle. **[5]**

Q8) a) The Hamiltonian for a harmonic oscillator is given by $H = \frac{p^2}{2m} + \frac{1}{2}kq^2$.

Using generating function $F_1 = \frac{1}{2}\sqrt{km}\,q^2\cot Q$, Show that the new Hamiltonian, $K(P,Q,t) = \sqrt{\frac{k}{m}}\,p$ **[5]**

b) What is velocity dependent potential? Where is it applicable? Obtain lagrangian & hamiltonian for a electron moving through electromagnetic field. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1274

[Total No. of Pages : 2

[5122]-102

M.Sc. (Semester I)

PHYSICS

PHY UT 502 : Electronics

(2013 Pattern) (5 - Credit)

Time : 3 Hour] *[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 internal block diagram of OPAMP. State function of each block. Define any two characteristics of OPAMP with its ideal and real values. **[4]**

b) Simplify following boolean expression and implement it using logic circuit.

$$Y = \sum m(0,2,8,9,10,12,14)$$ **[3]**

c) Draw circuit diagram of variable voltage regulator using Ic LM 317. Derive expression for its output voltage. **[3]**

Q2) a) Draw circuit diagram for full - wave precision rectifier. Explain its opecation. **[4]**

b) Design astable multivibrator using Ic 555 for fout = 10 KHz & D = 60 % **[3]**

c) Draw circuit diagram of 3-bit serial up-DOWN counter. Explain its working. **[3]**

Q3) a) Design Second order butterworth low pass filter with higher chtoff frequency of 5 KHz. **[4]**

b) Explain the concept of DC-DC converter. Where is it used? **[3]**

c) How PLL IC 565 can be used? as frequency multiplier? **[3]**

P.T.O

Q4) a) Draw circuit diagram of 2 - OPAMP function generator. How can you vary its frequency. amplitude and symmetry? **[4]**

b) Design 4 - bit binary weighted type DAC derive expression for its output voltage. **[3]**

c) Define three characteristics of voltage regulator. state its ideal values. **[3]**

Q5) a) Draw circuit diagram for Vco using IC 566. Derive formula for its out put frequency. **[4]**

b) Design a schmitt trigger using OPAMP, with bysterisis of 1V (Given Vcc = ± 10v) **[3]**

c) Design a notch filter using OPAMP to suppress frequency of 1 KHz with bandwidth of 100 Hz and Quality factor of 10. **[3]**

Q6) a) Design MOD - 7 counter using IC 7490 with and without use of additional external logic gates. **[4]**

b) Design monostable multivibrator using OPAMP to genezate period of 1μs. **[3]**

c) Draw internal blocks of IC 723. Explain function of each block. **[3]**

Q7) a) What is universal shift register? Draw internal block diagram of Ic 7495. Explain its various modes of operation. **[5]**

b) Write a note on successive approximation type ADC. **[5]**

Q8) a) Draw internal block diagram of IC 555. How it can be used as astable multivibrator? Derive expression for its output frequency and duty cycle. **[5]**

b) What will be the resolution of R-2R type 8 - bit DAC if logic O = OV and logic1 = 16V. Also determine its analog output if digital input is FOH and OFH. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1275

[Total No. of Pages : 3

[5122]-103

M.Sc. (Semester I)

PHYSICS

PHYUT 503 : Mathematical Methods in Physics

(2013 Pattern) (5 - Credit)

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

Instructions to the candidates:

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

Q1) a) $Let\ A = \begin{bmatrix} 4 & 1 & -1 \\ 2 & 5 & -2 \\ 1 & 1 & 2 \end{bmatrix}$ find all eigen values of A. **[4]**

b) Find L {sinhat} **[3]**

c) Check whether cauchy - Riemann equations are satisfied or not for $f(z) = \cos x - i\sinh y$ **[3]**

Q2) a) Determine whether or not u and v are linearly dependent where :

$u = 2t^2 + 4t - 3,\ u = 4t^2 + 8t - 6$ **[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) Explain why set S = {(2,1,-2), (-2,-1, 2), (4, 2, -4)} is not a basis of R^3? **[3]**

P.T.O

Q3) a) Using Rodrigue's formula for hermite's polynomials obtain hermite polynomials $H_o(x)$, $H_1(x)$, $H_2(x)$. **[4]**

b) The function f (x) is represented as $f(x) = \begin{cases} -k & -\pi < x < o \\ k & o < x < \pi \end{cases}$ Find the fourier coefficient b_n. **[3]**

c) Express v = (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]**

Q4) a) Find v such that f (t) = U + iv is analytic where $u = e^{-x}(x\sin y - y\cos y)$ **[4]**

b) Determine whether or not the following functions are linearly dependent. $f(t) = \sin t$. $g(t) = e^t$, $h(t) = t^2$ **[3]**

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

Q5) a) Definite fourier series and state dirichlet conditions. **[4]**

b) State and prove cauchy - schwarz inequality for inner product space. **[3]**

c) If $L\{f(t)\} = f(s)$, then find $L\{f'(t)\}$ **[3]**

Q6) 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. **[4]**

b) Apply cauchy integral formula to the integral $\phi \frac{e^{kz}}{z}$, k is real constant. to show |z| = 1 that $\int_0^{2\pi} e^{k\cos\theta} \cos(k\sin\theta)\, d\theta = 2\pi$ **[3]**

c) Find $L^{-1}\left\{\frac{s}{(s^2 + a^2)^2}\right\}$. **[3]**

Q7) a) Prove the recurrence relation for legendre polynomial

$$P^{1}_{n+1}(x) + P^{1}_{n-1}(x) = 2x P^{1}_{n}(x) + P_{n}(x)$$ **[5]**

b) Diagunalize the given matrix $D = \begin{bmatrix} 5 & 6 \\ 3 & -2 \end{bmatrix}$ **[5]**

Q8) a) State and prove the convolution theorem for fourier transform **[5]**

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 $\{f_1 = (1,1)\ f_2(-1, 0)$ **[5]**

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Total No. of Questions : 8] **SEAT No. :**

P1276 **[Total No. of Pages : 3**

[5122] - 104
M.Sc. (Physics) (Semester - I)
PHYUT-504: ATOMS, MOLECULES AND LASERS
(2013 Pattern 5 Credit)

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

Instructions to the candidates:

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

Given :

Mass of electron = 9.1×10^{-31} kg

Electronic charge = 1.6×10^{-19} coulomb

Planck's constant = 6.626×10^{-34} Js

Boltzmann constant = 1.3805×10^{-23} J/K.

lev = 1.6021×10^{-19} J

Bohr magnetran = 9.27×10^{-24} A - M^2

Boltzmann constant = 8.61×10^{-5} eV/K.

Q1) a) Explain principle and working of a Ruby laser. **[4]**

b) What is nuclear 9_N factor for 19_F nucleus which has magnetic moment of 2.6273 μN.

Given: Nuclear spin quantum for 19_F = ½. **[3]**

c) Draw block diagram of NMR spectrometer and explain its working. **[3]**

Q2) a) Determine $\frac{e}{m}$ for an electron when zeeman components of 500 nm spectral line are 0.0106 nm apart kept in a magnetic field of 0.40T. **[4]**

b) What is hyperfine structure? Hence obtain an expression for hyperfine splitting constant. **[3]**

c) Discuss medical applications of laser. **[3]**

P.T.O.

Q3) a) Explain the principle of ESR. Draw block diagram of ESR spectrometer. **[4]**

b) The ratio of population of two energy levels out of which upper one corresponds to metastable state is 1.059×10^{-30}. Find wavelength of light emitted at temperature, T = 330 K. **[3]**

c) Evaluate lande 9– factor for $2P\frac{1}{2}$ and $2P\frac{3}{2}$ states in $2_P \rightarrow 2_S$ transition for Na D_1 and D_2 line. **[3]**

Q4) a) What is anomalous Zeeman effect? Derive formula for AV in this case. **[4]**

b) List four quantum numbers defining quantum state of an electron and write down their allowed values. **[3]**

c) Discuss industrial applications of lasers. **[3]**

Q5) a) Explain following terms. **[4]**

i) Population inversion and metastable state.

ii) Spontaneous and stimulated emission.

b) State and explain hund's rule of maximum multiplicity. **[3]**

c) The band origin of a transition in C2 is observed at 19.378 Cm^{-1}, while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively $B^1 = 1.7527\ Cm^{-1}$ and $B^{11} = 1.6326\ Cm^{-1}$. Estimate the position of band head. Which state has larger internuclear distance? **[3]**

Q6) a) State and explain franck condon principle. **[4]**

b) What is holography? How does it differs from photography? **[3]**

c) Explain Russel - Saunder's LS coupling scheme for suitable electron configuration. **[3]**

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

b) With energy level diagram of neodymium ion in crystal, explain working of Nd: YAG laser. **[5]**

Q8) a) Show that the thereshold condition for laser action is: **[5]**

$$\alpha_{th} = \alpha_s = \frac{1}{2L} \times Ln \frac{1}{r_1 r_2}$$

Where symbols have usual meanings.

b) Find the relative population of the two states in a ruby laser that produces a light of wavelength 6943 A° at 300K and at 500K comment on the relative population at these temperatures. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1277 **[Total No. of Pages : 2**

[5122] - 201
M.Sc. (Physics) (Semester - II)
PHYUT 601: ELECTRODYNAMICS
(2013 Pattern) (5 Credits)

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

Instructions to the candidates:

1) ***Attempt any five questions from the following.***
2) ***Draw neat labelled diagrams whever 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) Explain the term 'momentum space' with the help of suitable example. **[4]**

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

c) Explain the term Hertz potential $\vec{Z}$. 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]**

Q2) a) Obtain an expression for e.m. field tensor $F_\mu r$. **[4]**

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

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

Q3) a) Show that power transferred to the e.m. Field through the motion of charge in volume V is given by:

$$-\int_V (\vec{j}.\vec{E})dv = \frac{d}{dt}\int_V \frac{1}{2}(\vec{E}.\vec{D} + \vec{B}.\vec{H})dV + \int_{C.S.} (\vec{E} \times \vec{H}).d\vec{s}$$ **[4]**

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

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

P.T.O.

Q4) a) Derive an expression for potential at a distant point using multipole expansion for a localised charge distribution in free space. **[4]**

b) Explain the term 'four vector potential? **[3]**

c) Calculate the frequency at which the skin-depth in sea water is 1meter.

Given: $\mu = \mu_o = 4\pi \times 10^{-7} \frac{Wb}{A\text{-}M}$ and 6 = 4.3 mho/m. **[3]**

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

b) Show that $(\vec{E}.\vec{B})$ is invarient under loventz transformations. **[3]**

c) Explain minkowski's space time diagram. **[3]**

Q6) a) Starting with maxwell's equations derive inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

b) State and prove poynting's theorem. **[3]**

c) Describe 'thomson cross - section' related to the radiation emission. **[3]**

Q7) a) Prove the relatiristic addition theorem for velocities. Hence show that any velocity added relatiristically to 'C' given the resultant velocity 'C' which is loventz invarient. **[5]**

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

Q8) a) Draw a suitable diagram and explain the magnetic interaction between two current loops. **[5]**

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

Total No. of Questions : 8] **SEAT No. :**

P1278 **[Total No. of Pages : 3**

[5122] - 202
M.Sc. (Physics) (Semester - II)
PHYUT-602: SOLID STATE PHYSICS
(2013 Pattern 5 Credits)

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

Instructions to the candidates:

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

Given :

Boltzman constant $= 1.38 \times 10^{-23}$ JK^{-1}

Plank's constant $= 6.623 \times 10^{-34}$ J–s.

Avogadro's number $= 6.023 \times 10^{23}$ $(Mole)^{-1}$.

Mass of electron $= 9.1 \times 10^{-31}$ kg.

Charge on electron $= 1.6 \times 10^{-19}$ C.

Bohr magnetron $= 9.27 \times 10^{-14}$ $A.m^2$

Permeability of free space $= 4\pi \times 10^{-7}$ H/m.

Q1) a) Prove that for kroning - 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) Explain meissner effect in superconductors. **[3]**

c) A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptibilty and the magnetization produced in a uniform magnetic field of 10^7 A/M at room temperature. **[3]**

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

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

c) A magnetic material has a magnetisation of 3300 A/M and flux density of 0.0055 Wb/m^2. Calculate the magnetising force and relative permeability of the material. **[3]**

P.T.O.

Q3) a) Give an account of weiss theory of Ferromagnetism. Deduce the expression for curie-weiss law. **[4]**

b) Derive an expression for london penetration depth in a superconductor. **[3]**

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

Q4) a) Explain various schemes of E-K representation. **[4]**

b) Define the terms.

i) Critical temperature

ii) critical field for a super conductor **[3]**

c) A paramagnetic material has 6.02×10^{28} atoms/m^3. and its fermi energy is 11.65ev. Determine pauli's paramagnetic susceptibility. **[3]**

Q5) a) What is cyclotron resonance? Obtain an expression for cyclotron frequency of Bloch electron. **[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 1.85A°. Estimate the order of diamagnetic susceptibility. **[3]**

Q6) a) Derive an expression for paramagnetic susceptibility using quantum theory of paramagnetism. **[4]**

b) Differenciate between antiferromagnetism and ferrimagnetism with suitable example. **[3]**

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

Q7) a) Set up an equation of motion of momentum per electron and hence obtain an expression for ac electrical conductivity of a metal. **[5]**

b) State and prove bloch theorem. **[5]**

Q8) a) Explain kronig-penny model, to study the energy spectrum of an electron. **[5]**

b) Distinguish between metals, semi conductors and insulators on the basis of band theory of solids. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1279

[Total No. of Pages : 2

[5122] - 203
M.Sc. (Semester - II)
PHYSICS
PHY UT-603: EXPERIMENTAL TECHNIQUES IN PHYSICS
(2013 Pattern) (5 Credit System)

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

Instructions to the candidates:

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

Constants:

1) Boltzmann constant, K_B = 1.38×10^{-23} J/K
2) Planck's constant , h = 6.63×10^{-34} J.S
3) Avogadro's number, N = 6.023×10^{23} /gm.mole
4) Mass of electron , Me = 9.1×10^{-31} kg.
5) Velocity of light,C = 3×10^{8} m/s.
6) Charge of electron, e = 1.6×10^{-19}C.

Q1) a) Explain the principle, construction and working of XPS. **[4]**

b) What are the different pumping concepts used in vacuum pumps? **[3]**

c) Write a short note on Microwave generator. **[3]**

Q2) a) Calculate the average nanoparticle size using scherrer formula.
(Given: Wavelength used for diffraction is Cu Kα - 0.154nm, full width at half maxima (FWHM) $\beta = 0.05$, $\theta_B = 60°$). **[4]**

b) Write a short note on auto and cross correction functions. **[3]**

c) Explain the term random signal. **[3]**

Q3) a) Calculate the value of static magnetic field of an ESR spectrometer, if the frequency of excitation is 9580 MHz.
(Given: Electron magnetic moment, $\mu_e = 9.285 \times 10^{-24}$J/T and the angular momentum number can have values + ½ or – ½ and lande's 'g' factor is 2.0023). **[4]**

P.T.O.

b) What is spectral analysis of signals. Explain in brief. **[3]**

c) Write a short note on errors in measurement. **[3]**

Q4) a) Explain the construction and working of thermocouple (Pirani) gauge. **[4]**

b) What are the important types of sensing properties of sensors? **[3]**

c) In an electron microscope, the accelerating voltage is 40 KV. Calculate the wavelength in nm. **[3]**

Q5) a) Explain the principle, working of atomic force microscopy (AFM). **[4]**

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

c) Write a short note on XRD technique. **[3]**

Q6) a) Write short note on vacuum system design. **[4]**

b) What is meant by mean free path? Calculate the mean free path for air at ambient temperature with pressure 10^{-5} torr. **[3]**

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

Q7) a) Explain the principle, construction and working of transmission electron microscope (TEM). **[5]**

b) Explain the basic principle and applications of optical tweezers. **[5]**

Q8) a) Explain the principle and Instrumentation of UV visible spectrometer. **[5]**

b) Explain the principle, construction and working of scanning tunnelling microscope.(STM) **[5]**

Total No. of Questions : 8]

SEAT No. :

P1280

[Total No. of Pages : 2

[5122] - 204
M.Sc. (Physics) (Semester - II)
PHYUT-604: QUANTUM MECHANICS - I
(2013 Pattern 5 Credit)

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

Instructions to the candidates:

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

Q1) a) What are ltermitian operators? Show that eigenvalues of Hermitian operator are real and eigenfunctions corresponding to distinet eigenvalues are orthogonal. **[4]**

b) Show that (Ln, Ly) = it Lz **[3]**

c) Using time independent perturbation theory obtain the first order correction to the n^{th} state of anharmonic oscillator with hamiltonian.

$$H = \frac{P^2}{2m} + \frac{1}{2}\ mw^2 x^2 + \lambda\ x^4$$ for small λ. **[3]**

Q2) a) Obtain clebsch - Gordon coefficients for a two non-interacting particles with angular momentum $j_1 = ½$ and $j_2 = ½$ **[4]**

b) Show that variation method gives anupper bound to the ground state energy. **[3]**

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

Q3) a) State and explain postulates of quantum mechanics. **[4]**

b) Explain projection operater? Why it is called a unit operator? **[3]**

c) Find the energy levels and eigen functions of Hamiltonian.

$$H = \begin{bmatrix} 1+E & E \\ E & -1+E \end{bmatrix}$$ Where E<<1, corrected upto first order in E using perturbation theory. **[3]**

P.T.O.

Q4) a) Obtain ferm's golden rule. **[4]**

b) Define hilbert space. Write expression for norm and scalar product in this space. **[3]**

c) Determine whether or not the function $f(x) = Ae^{-x2/2}$ is an eigen function of the operater $\left(\frac{d^2}{dx^2} - x^2\right)$ If it is, what is its eigenvalue? **[3]**

Q5) a) Using WKB approximation obtain bohr's quantization condition. **[4]**

b) Write note on Dirac S Function and represent it graphically. **[3]**

c) If $\hat{A}$ and $\hat{B}$ are operators, then prove that **[3]**

i) $(\hat{A}^+)^+ = \hat{A}$ and ii) $(\hat{A}\hat{B})^+ = \hat{B}^+\hat{A}^+$

Q6) a) When a set of functions $\{\psi a\}$ will be orthonormal and complete? hence obtain the closure relation $\sum_a \psi_a(x)\psi_a^*(x) = \partial(x-x)$ **[4]**

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

c) Using trial wave function $\psi(x) = Ae^{-\alpha x2}$ Whare α is variation parameter, obtain an upper bound for ground state energy of linear harmonic oscillator **[3]**

Q7) a) Develope time dependent perturbation theory to obtain first order correction to the amplitude $a_m^1(t)$ **[5]**

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

Q8) a) Obtain eigenvalue spectrum of J^2 and J_Z operators. **[5]**

b) What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1281

[Total No. of Pages : 2

[5122] - 1001
M.Sc. (Physics Theory) (Semester - I)
PHYUT 501: CLASSICAL MECHANICS
(2013 Pattern) (4 Credit)

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

Instructions to the candidates:

1) ***Attempt any five questions out of right questions.***
2) ***Neat diagram must be drawn wherevere necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators is allowed.***

Q1) a) Prove that [F,GS] = [F,G] S + G [F,S]. **[4]**

b) Write the types of constraints for

i) Deformable bodies.

ii) Gas filled hollow sphere **[3]**

c) Obtain the Lagrangion & equation of motion for simple pendulum. **[3]**

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

b) Show that, A functions whose Poisson bracket with Hamiltonian vanishes is a constant of motion. **[3]**

c) Using poisson bracket, prove that [Lz, Lx] = Ly. **[3]**

Q3) a) Show that for spherical surfaces geo desic are great circles **[4]**

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

c) Show that generating function $F = \Sigma$ Qi Pi generates identity transformation. **[3]**

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

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

c) What are cyclic co-ordinates ? Explain with suitable example. **[3]**

P.T.O.

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

b) Discuss larmour precision. **[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]**

Q6) a) Using poisson bracket, show that the transformation.

$$Q = e^{-q}(1 - P^2 e^{2q})^{1/2}$$

$$P = Tan\frac{^{-1}e^{-q}(1 - P^2 e^{2q})^{1/2}}{P}$$ is canonical. **[4]**

b) What are inertial frames of reference? How two inertial frames & of &' are related by galilean transformation? **[3]**

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

Q7) a) State & prove theorem on total energy. **[5]**

b) A particle is moving under a central force field. Prove that

$$F\left(\frac{1}{u}\right) = \frac{-J^2}{m}(u^3 + 2z\tau^2 u^5)$$ **[5]**

Q8) a) Show that shortest distance between two points in a plane is straight line. **[5]**

b) Write a note on 'Integrable power laws'. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1282

[Total No. of Pages : 2

[5122] - 1002
M.Sc. (Physics) (Semester - I)
PHYUT 502: ELECTRONICS
(2013 Pattern) (4 - Credit)

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 whervere necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Draw circuit diagram of astable multivibrator using OPAMP. Explain its operation. How it can be modified to produce pulsating waveform? **[4]**

b) Design regulated power supply using IC 723 to produce vout = 6 volt and I_{SC} = 65mA. **[3]**

c) Obtain a reduced Boolean expression using K - Map and implement it using logic circuit for following function

$Q = \Pi M (0,1,3,5,6,7,10,14,15)$ **[3]**

Q2) a) Draw internal block diagram for VCO IC 566. Explain its operation. Derive formula. **[4]**

b) If Logic O = OV and logic 1 = 16V, determine output analog voltage for digital input 0011 and 1001 for R-2R type DAC. Also determine its resolution. **[3]**

c) Draw scaling circuit using IC 7490 for MOD-3, MOD-6 and MOD-9 counter. **[3]**

Q3) a) Draw internal block diagram for -3 pin regulator. Explain function of each block. Draw practical circuit of 12V regulated power supply using suitable 3-pin regulator. **[4]**

b) Design a monostable multivibrator using IC 555 to produce a pulse of 1 msec. duration. **[3]**

c) Design MOD-7 Serial counter using flipflops. Explain its operation with reference to timing diagram. **[3]**

P.T.O.

Q4) a) Draw circuit diagram of 4-bit parallel UP-DOWN counter. Explain its working. **[4]**

b) Design variable voltage regulator using IC LM317 to produce Vout = 2 Volt to 20 Volt. **[3]**

c) Draw circuit diagram of dual slope ADC. Explain its working and show that output period is proportional to input voltage **[3]**

Q5) a) Draw internal block diagram of IC 555. How it can be connected as monostable multivibrator? Explain its operation. **[4]**

b) What is DC-DC converter. Explain its operation. State two applications. **[3]**

c) Draw circuit diagrams of 2-OPAMP function generator. Derive expression for its input frequency. **[3]**

Q6) a) Draw circuit diagram of discrete voltage regulator with fold-back current limiting. Explain its operation. **[4]**

b) Define four characteristics of DAC. **[3]**

c) Write a short note on SMPS **[3]**

Q7) a) What is PLL? Draw internal block diagram of IC 565. Explain its operation. Define capture-range, Lock range and free-running frequency. State its formulae. **[5]**

b) Draw internal block diagram of IC 7490.Explain its working. How it can be used as MOD-19 counter? **[5]**

Q8) a) Draw internal block diagram of IC 7495. Explain its operation. How it can be used as shift left and shift right register? **[5]**

b) Draw circuit diagram of counter-ramp type ADC. Explain its working state its limitations. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1283 **[Total No. of Pages : 3**

[5122] - 1003
M.Sc. (Semester - I)
PHYSICS
PHYUT-503: Mathematical Methods in Physics
(2013 Pattern) (4 - Credits)

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) Let $A = \begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$

i) Find all eigenvalues and corresponding eigenvectors

ii) Find a non-singular matrix P such that $D = P^{-1}AP$ is diagonal. **[4]**

b) Express $v = (2, -5,3)$ in R^3 as a linear combination of the vector $u_1 = (1, -3,2)$, $u_2 = (2,-4,-1)$, $u_3 = (1,-5,7)$ **[3]**

c) Prove the recurrence relation for Hermite polynomials $H_{n+1}(x) = 2xH_n(x) - 2n\, H_{n-1}(x)$ **[3]**

Q2) a) Given $f(x) = \begin{cases} 0 & 0 < x < L \\ 1 & L < x < 2L \end{cases}$ Expand $f(x)$ in a fourier series of period 2 L. **[4]**

b) Determine whether (1,1,1,1), (1,2,3,2), (2,5,6,4), (2,6,8,5) form a basis of R^4 **[3]**

c) For Bessel function of first kind show that $J_{n-1}(x) - J_{n+1}(x) = 2J_n'(x)$ **[3]**

Q3) a) Write down the Rodrigue's formula for Legendre polynomials and determine the first three polynomials $P_0(x)$, $P_1(x)$, $P_2(x)$ **[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 Fourier cosine transform of $f(x) = e^{-2x} + 4e^{-3x}$ **[3]**

P.T.O.

Q4) a) Consider the following two basis of R^2 :

$S = \{u_1,u_2\} = \{(1,2), (3,5)\}$ and

$S^1 = \{v_1,v_2\} = \{(1,-1), (1,-2)\}$

Find the change of basis matrix P from S to the "new" basis S'. **[4]**

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

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

c) Find K so that u = (1,2,k,3) and v = (3,k,7,–5) in R^4 are orthogonal. **[3]**

Q5) a) For Legendre polynomial show that $P_n(0) = 0$ when"n" is odd

$$P_n(0) = \frac{(-1)^{n/2}1.3.5.7.....(n-1)}{2^{n/2}\left(\frac{n}{2}\right)!} \text{ ,when"n" is even} \quad \textbf{[4]}$$

b) Show that the Laplace transform of t^4 is $\frac{n!}{s^{n+1}}$. **[3]**

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

Q6) a) Prove the recurrence relation for Laguerre polynomials

$L_{n+1}(x) = (2n+1-x)\, L_n(x) - n^2\, L_{n-1}(x)$ **[4]**

b) Find the characteristic polynomial $\Delta(t)$ of each of the following matrices.

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

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

Q7) a) Let V be the vector space of polynomials $f(t)$ with inner product

$\langle f,g \rangle \int_{-1}^{1} f(t)g(t)dt$ Apply the Gram - Schmidt orthogonalization process to $[1, t, t^2, t^3]$ to find an orthogonal basis $[f_0, f_1, f_2, f_3]$ with inner coefficients for $P_3(t)$. **[5]**

b) Solve the following differential equations by Laplace transform

$$\frac{dx}{dt} - y = e^t, \frac{dy}{dt} + x = \sin t \text{ given } x(0) = 1, y(0) = 0$$ **[5]**

Q8) a) Expand $f(x) = x$, $0 < x < 2$ in a half - range co-sine series, then write Parseval's identify corresponding to this Fourier cosine series. **[5]**

b) Find the fourier series which represent the function

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

and $f(x + 2\pi) = f(x)$ in the interval $-\pi \le x \le \pi$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1284

[Total No. of Pages : 3

[5122] - 1004
M.Sc. (Semester - I)
PHYSICS
PHY UT-504: Atoms and Molecules
(2014 Pattern) (4 - Credits)

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 $= 9.109 \times 10^{-31}$ kg

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

Plank's constant $= 6.626 \times 10^{-34}$ joule - sec

Boltzmann constant $= 1.381 \times 10^{-23}$ joule/^{o}K

Avogadro's number $= 6.023 \times 10^{23}$ atoms/mole

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

Bohr magneton $\mu_B = 9.274 \times 10^{-24}$ joule/tesla

Q1) a) What is Paschen - Back effect. Explain Paschen-Back effect in case of sodium atom. **[4]**

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

c) ESR is observed in atomic hydrogen with an instrument operating at 9.5GHz. If the g value for the electron in hydrogen is 2.0026.What is magnetic field applied. **[3]**

Q2) a) Define dissociation energy for a diatomic molecule. Obtain an expression for V_{max} corresponding to dissociation limit. **[4]**

b) Write a note on chemical shift in NMR and hence give formulas for chemical shift. **[3]**

c) What 'g' factor? Calculate it for $^{2}f_{1/2}$ term. **[3]**

P.T.O.

Q3) a) Explain the principle of NMR. With the help of block diagram, explain working of a typical NMR spectrometer. **[4]**

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

c) The Zeeman components of 500nm spectral line are 0.0106nm apart when applied magnetic field is 0.4T. Find e/m ratio of an electron from this data. **[3]**

Q4) a) Explain Laue theory of X–ray diffraction. **[4]**

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

c) An NMR, signal for a compound is found to be 180 Hz downward from rms peak using a spectrometer operating at 60 MHz. Calculate shift in ppm. **[3]**

Q5) a) What is Zeeman effect? Discuss anomalous Zeeman - effect. **[4]**

b) In ESR write a note on the different contributions to the total Hamiltonian of the electron in a system. **[3]**

c) Calculate the highest possible frequency for silicon if the Debye temperature is 570K. **[3]**

Q6) a) State the principle of ESR. Explain working of ESR spectrometer with the help of a block diagram. **[4]**

b) State and explain the three basic rules, which determine how electrons occupy orbitals. **[3]**

c) The value of x_e for lower and upper states of C_2 are 0.00711 and 0.00919 respectively. Find the number of levels in the upper and lower states. **[3]**

Q7) a) State and explain Frank-Condon principle. **[5]**

b) Derive the dispersion relation for a linear monatomic lattice. **[5]**

Q8) a) Discuss the rotational fine structure of electronic vibrational transition. **[5]**

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

Total No. of Questions : 8]

SEAT No. :

P1285

[Total No. of Pages : 2

[5122] - 1005
M.Sc.(Semester - I)
PHYSICS
PHYUT-505: Experimental Techniques in Physics - I
(2013 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) Explain the vacuum system design with the help of schematic diagram. **[4]**

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

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

Q2) a) What is pump down time? Derive an expression for the pump down time. **[4]**

b) Define through put, impedance and conductance of a vacuum line'. **[3]**

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

Q3) a) What is throttling process? Prove that the enthalpy remains constant in a throttling process. **[4]**

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

c) Explain pumping speed of a vacuum pump. On what factors does it depend? **[3]**

Q4) a) With neat diagram explain the construction and working of a rotary pump. **[4]**

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

c) Explain different flow regimes for gases. **[3]**

P.T.O.

Q5) a) With neat diagram explain the construction and working of molecular drag pump. **[4]**

b) Draw a neat labbled diagram of hot cathode (triode) ionization gange. **[3]**

c) Calculate the pump down time to reduce the pressure 760 torr to 10^{-1} torr if volume of the chamber is 50 lit and pump speed is 75 lit/ min. **[3]**

Q6) a) With the help of neat diagram explain the construction of optical tweezers. **[4]**

b) Explain ultimate pressure and degasing. **[3]**

c) Explain partical pressure exerted by the mixture of gases. **[3]**

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

b) Explain with neat diagram, the working of bayard -Alpert ionization gange. **[5]**

Q8) a) With neat diagram explain working of Mc Leod gange. **[5]**

b) With neat diagram explain working of pirani gange. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1286

[Total No. of Pages : 2

[5122] - 2001
M.Sc. (Semester - II)
PHYSICS
(PHY UT : 601) Electrodynamics
(2014 Pattern) (4 Credits)

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 calculator is allowed.***

Q1) a) Starting with Maxwell's equations, derive inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

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

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

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

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

c) If the average distance between the sun and earth is 1.5×10^{11} m, find the average solar energy incident on the earth. Given: $P = 3.8 \times 10^{26}$ watts. **[3]**

Q3) a) A plane e.m. wave is propogated through a stationary medium. Assuming the solution of wave, show that it satisfies the relation CBz = Ey. **[4]**

b) Explain Ampere's circuital law and write Maxwell's fourth equation of e.m. field. **[3]**

c) Two identical bodies move towards each other, the speed of each being 0.9C. What is their speed relative to each other. **[3]**

P.T.O.

Q4) a) Derive an expression for e.m. field tensor $F\mu\gamma$. **[4]**

b) Explain the term 'four vector potential? **[3]**

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

Given: $\mu \simeq \mu_0 = 4\pi \times 10^{-7} \frac{\mathrm{W}\,b}{A - m}, \in_0 = 2.3,$

$\in_0 = 8.85 \times 10^{-12} \frac{\mathrm{C}^2}{\mathrm{N} - m^2}$ and $\sigma = 2.56 \times 10^{-4} \frac{\mathrm{m\,ho}}{m}$ **[3]**

Q5) a) Write an expression for magnetic field $\vec{\mathrm{B}}$ at a point and show that it's curl equals to $\mu_0 \vec{j}$. **[4]**

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

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

Q6) a) Derive Faraday's law of induction for moving medium. **[4]**

b) Show that $(\mathrm{C}^2\,\mathrm{B}^2 - \mathrm{E}^2)$ is invariant under Lorentz transformations. **[3]**

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

Q7) a) State and prove Poynting's theorem. **[5]**

b) Prove the relativistic addition theorem for velocities. Hence show that any velocity added relativistically to 'C' gives the resultant velocity 'C' which is Lorentz invariant. **[5]**

Q8) 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]**

Total No. of Questions : 8]

SEAT No. :

P1287

[Total No. of Pages : 3

[5122] - 2002
M.Sc. (Semester - II)
PHYSICS
PHY UT - 602: Solid State Physics
(2014 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Constants:

1)	Boltzmann constant	:	K_β	$= 1.38 \times 10^{-23}$ J/K
2)	Plank's constant	:	h	$= 6.623 \times 10^{-34}$ Js
3)	Avogadro's number	:	N	$= 6.023 \times 10^{23}$ /mole
4)	Mass of electron	:	m_e	$= 9.1 \times 10^{-31}$ kg
5)	Charge on electron	:	e	$= 1.6 \times 10^{-19}$C
6)	Bohr magneton	:	μ_B	$= 9.27 \times 10^{-24}$Am^2
7)	Permeability of free space	:	μ_0	$= 4\pi \times 10^{-7}$ H/m
8)	Permittivity of free space	:	$\in_0$	$= 8.85 \times 10^{-12}$ C^2/Nm^2

Q1) a) What is ferromagnetism? Explain the molecular field theory of ferromagnetism and derive the Curie - Weiss law. **[4]**

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

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

Q2) a) What is quenching of orbital angular momentum? Explain the paramagnetism in iron group ions using this concept. **[4]**

b) Explain how is antiferromagnetism different from ferromagnetism. What is the importance of the Neel temperature? **[3]**

c) Distinguish between metals, semiconductors & insulators using the band theory. **[3]**

P.T.O.

Q3) a) Explain the difference between type I & type II super conductors. Give suitable examples to support your answer. **[4]**

b) Explain the cause of diamagnetism & paramagnetism in a material. **[3]**

c) Silicon has a band gap of 1.1 eV. What is the longest wavelength it will absorb? **[3]**

Q4) a) Draw hysterisis curves and explain the difference between hard and soft magnets. Mention applications of each type. **[4]**

b) Explain the Meissner effect observed in super conductors. **[3]**

c) The average Bohr radius of He atom in its ground state is 0.53 nm. Its density is 0.178kg/ m^3 and atomic weight is 4.003 amu. Calculate its diamagnetic susceptibility. **[3]**

Q5) a) What are cooper Pairs? Explain how they are responsible for super conductivity in a material? **[4]**

b) Explain the following terms for a solid.

i) Fermi energy, ii) Fermi velocity, iii) Fermi surface and iv) Fermi vector. **[3]**

c) Show that for the Kronig - penny potential with P<<1, the energy of the lowest at band is at K = 0 is $E = \frac{h^2 P}{ma^2}$ **[3]**

Q6) a) Draw neat diagrams and explain the extended, reduced and periodic zone systems. How are they useful? **[4]**

b) Explain the following terms for a super conductor.

i) Critical field, ii) Critical current and iii) Isotope effect. **[3]**

c) Explain the terms anisotropy energy & Bloch wall with reference to magnetization. **[3]**

Q7) a) What are the assumptions of quantum theory of paramagnetism? Derive an expression for paramagnetic susceptibility. **[5]**

b) State the assumptions of the Kronig Penny model. Show that the energy spectrum of an electron consists of allowed and forbidden energy bands on the basis of these assumptions. **[5]**

Q8) a) Derive the Loudon equation for super conducting state and obtain an expression for penetration depth. **[5]**

b) Describe the motion of electron in a one dimensional periodic potential. Hence explain the concept of effective mass m*. Explain the meaning of negative effective mass with the help of the m* K – curve. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1288 **[Total No. of Pages : 2**

[5122] - 2003
M.Sc. (Semester - II)
PHYSICS
PHY UT - 603 : Quantum Mechanics - I
(2014 Pattern) (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 calculators allowed.***

Q1) a) Using ground state wave function of harmonic oscillator find $\langle x \rangle$ and $\langle x^2 \rangle$. **[4]**

b) Define unitary operator. Show that the norm of any state $|\psi\rangle$ does not change under unitary transformation. **[3]**

c) Show that eigen value of L_z operator is $m\hbar$. Where $m = 0, \pm 1, \pm 2, ...$ **[3]**

Q2) a) A linear operator $\hat{F}$ takes on a vector $|\psi\rangle$ as $\hat{F}|\psi\rangle = |\chi\rangle$. Represent $\hat{F}$ as matrix elements in A-representation. **[4]**

b) State and explain Fermi Golden rule. **[3]**

c) Obtain Clebsch Gorden coefficients for $j_1 = ½$ and $j_2 = ½$ **[3]**

Q3) a) Using Bohr - Sommerfeld condition show that the WKB approximation gives the correct energy levels for all states of linear harmonic oscillator. **[4]**

b) If an arbitrary wave function $\psi = \sum_a C_a \phi_a$ and ϕ_a are eigen functions of $\hat{A}$, then show that $\langle A \rangle = \sum_a |C_a|^2 .a$ **[3]**

c) Let $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Show that α and β are eigen vectors of Pauli's spin matrices. **[3]**

P.T.O.

Q4) a) Using Schrödinger's steady state equation obtain energy eigen values for one dimensional infinite square well potential. **[4]**

b) Explain unitary transformation. Show that operator equations remain unchanged under this transformation. **[3]**

c) Obtain the matrices J_x and J_y for j = ½. **[3]**

Q5) a) State and prove closure property for the functions. $\{\psi_a\}$ which are orthonormal and form a complete set. **[4]**

b) Define projection operator. Show that the sum of all projection operators leaves any state vector $|\psi\rangle$ unchanged. **[3]**

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

Q6) a) Show that for Hermitian operator the eigen values are real. Also prove that for this operator any two eigen functions belonging to distinct eigen values are mutually orthogonal. **[4]**

b) State the requirements on wave functions to be acceptable wave functions. **[3]**

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

Q7) a) State physical significance of eigen values and eigen functions of an observable. State expansion postulate. **[5]**

b) Using time independent perturbation theory, obtain the first order correction in energy for linear harmonic oscillator in first excited state for perturbation $H' = \lambda x^4$. **[5]**

Q8) a) Obtain coefficients $C^{\pm}_{lm}$ in equation $L\pm|l,m\rangle = C^{\pm}_{lm}|l,m\pm1\rangle$ where

$|l,m\rangle$ are simultaneous eigen states of L^2 and L_z operators and L + and L– are raising and lowering operators. **[5]**

b) Using variational method, obtain ground state energy of hydrogen atom by using trial wave function $\psi(r) = Ae^{-\alpha r}$. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1289

[Total No. of Pages : 3

[5122] - 2004
M.Sc. (Semester - II)
PHYSICS
PHYUT-604: Lasers
(2014 Pattern) (4 - Credits)

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 necesssary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Values of constants:

1)	Boltzmann constant	=	K_B	$= 1.38 \times 10^{-23}$ J/K
2)	Planck's constant	=	h	$= 6.63 \times 10^{-34}$ Js
3)	Charge on electron	=	e	$= 1.6 \times 10^{-19}$C
4)	Velocity of light	=	c	$= 3 \times 10^{8}$ m/s

Q1) a) What are the important features of stimulated emission? Discuss the essential requirements of producing laser beam. **[4]**

b) What do you mean by purity of spectral line? How is it related to coherence length? **[3]**

c) A laser beam has bandwidth of 2500Hz. What will be its coherence time and coherence length? **[3]**

Q2) a) Explain the basic principle and operation of dye laser. How it can be used as tunable laser. **[4]**

b) What do you mean by passive cavity life time? Derive relation between quality factor (Q) and life time (Tc) of cavity. **[3]**

c) Explain in brief various geometries of resonating cavities used in laser construction. **[3]**

P.T.O.

Q3) a) State different types of excitation methods used for pumping in CO_2 laser. Which one is more advantageous. Explain any one method in detail. **[4]**

b) Draw energy level diagram of He-Ne laser. Explain its operation with reference to all possible transitions. How undesired wavelength can be eliminated from output? **[3]**

c) Derive threshold condition for producing laser oscillations. How it can be practically achieved. **[3]**

Q4) a) Write a detailed note on Nd-YAG laser. **[4]**

b) What do you mean by TEA laser? State its advantages. Why TEA Nitrogen laser require only one reflecting mirror? **[3]**

c) A dye laser gives homogeneously broadened emission from 520 nm to 620 nm with peak emission at 565nm. The emission starts from lowest energy level of S_1. Calculate the energy width of transition from S_1 level to S_0 level. **[3]**

Q5) a) Explain in detail the construction, principle and working of ruby laser with reference to energy level diagram. **[4]**

b) A He - Ne laser produces wavelength of 632.8 nm with beam waist of 0.6 mm. Calculate divergence angle in radians. **[3]**

c) State various types of line broadening associated with laser beam. Explain any one type in detail. **[3]**

Q6) a) In a laser scheme emitting at a wavelength of 0.94 μm, lines are separated by 300 GHz. If refractive index of laser material is 3.3, calculate **[4]**

i) Length of cavity and

ii) Number of longitudinal modes.

b) Explain the principle and working of semiconductor diode laser. **[3]**

c) What do you mean by Q - switching? Explain two methods of Q-switching. **[3]**

Q7) a) Explain in detail, the principle and operation of excimer laser. State its four applications. **[5]**

b) With a neat diagram, explain the use of laser in welding and cutting processes in metal industry. **[5]**

Q8) a) A rod of certain solid state laser material of length 10cm and diameter 2cm contains 2×10^{25} ions per cubic meter. In an excited state all ions in the upper laser level deexcite Simultaneously emitting photons in same direction. Calcualte **[5]**

i) The maximum energy contained in a radiated pulse of wavelength 6.6×10^{-7}m.

ii) If the pulse duration is 10^{-7} seconds, calculate the average power of the pulse during its existance.

b) What is holography? Explain the process used in recording and reconstruction of a hologram. State different types holography. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1290

[Total No. of Pages : 2

[5122] - 2005
M.Sc. (Physics) (Semester - II)
PHY UT-605: EXPERIMENTAL TECHNIQUES IN PHYSICS - II
(2014 Pattern) (4 Credit Based System)

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	$= 1.38 \times 10^{-23}$ J/K.
2)	Plank's constant	:	h	$= 6.63 \times 10^{-34}$ Js
3)	Avogadro's number	:	N	$= 6.02 \times 10^{23}$ /gm mole
4)	Mass of electron	:	Me	$= 9.1 \times 10^{-31}$ kg.
5)	Charge of electron	:	e	$= 1.6 \times 10^{-19}$C.
6)	Velocity of light	:	c	$= 3 \times 10^{8}$ m/s

Q1) a) Explain principle, construction and working of atomic force microscope (AFM.) **[4]**

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

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

Q2) a) Derive the scherrer formula for the average nanoparticle size calculation. **[4]**

b) Explain the principle of operation of pressure sensors with examples. **[3]**

c) Explain different modes of STM (Scanning tunnelling Microscope). Also mention it's applications. **[3]**

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]**

P.T.O.

b) Explain the operating principle of accoustic sensors. Give one example. **[3]**

c) Write short note on principle of Neutron diffraction. **[3]**

Q4) a) In an electron microscope sysetm, calculate the wavelength in nm, if the applied, accelerating voltage is 100 Kv. **[4]**

b) Explain the principle of nuclear magnetic Resonance (NMR) **[3]**

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

Q5) a) Give classification of sensors in brief. **[4]**

b) Write short note on advantage of Atomic force microscope (AFM) over scanning tunnelling microscope (STM) **[3]**

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

Q6) a) Explain the principle, instrumentation and working of differential thermal Analysis (DTA) **[4]**

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

c) What will be the resolution of an optical microscope, whose numerical aperature is 1 and suppose wavelength used is 500nm? Also comment on the result. **[3]**

Q7) a) With the help of schematic diagram explain the basic components of transmission Electron microscope (TEM). What cares should be taken while preparing sample for TEM. **[5]**

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

Q8) a) Discuss the principle and instrumentation of UV- visible spectrometer. **[5]**

b) In a X - ray diffractometer, wavelength of Cukα = 0.154 nm and the inter planar distance of given sample is 0.3nm. Calculate the angles for diffraction for first, second and third order diffractions. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1291 **[Total No. of Pages : 3**

[5122] - 3001
M.Sc. (Semester - III)
PHYSICS
PHY UT-701: Statistical Mechanics in Physics
(2013 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 necesssary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Constants:

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

Q1) a) What is classical limits? Explain, how quantum distribution laws are reduced to classical MB distribution? **[4]**

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

c) The table given below shows the energy parameter and accessible state for two systems.

System 1	System 2
E_1=2,3,4 units	E_2 = 5,6,7 units
Ω_1 = 5,25,75	Ω_2 = 100,150,200

The systems are kept in contact and undergo thermal interaction only. Obtain distribution for 9 units of energy in equilibrium state. **[3]**

P.T.O.

Q2) a) Show that black body radiation pressure is equal to one third of the energy density. **[4]**

b) Determine whether the electron gas in copper at room temperature is degenerate or non- degenerate (Concentration of electron in copper = $8.5 \times 10^{28} m^{-3}$) **[3]**

c) Two states with difference of energy 4.8×10^{-14} erg occur with relative probability e^2. Calculate the temperature. **[3]**

Q3) a) On the basis of canonical distribution , obtain the law of atmosphere. **[4]**

b) Write a short note on "Gibb's Paradox". **[3]**

c) Write a note on White dwarf. **[3]**

Q4) a) Show that Maxwell velocity distribution for a mole is given by

$$f(x)d^3v = n\left(\frac{m}{2\pi KT}\right)^{3/2} e^{\frac{-mv^2}{2KT}} d^3v$$ **[4]**

b) Write the assumption of Debye model. Hence, calculate γ_D^3 Where γ_D is Debye cut - off frequency. **[3]**

c) A system with just two energy levels is in thermal equilibrium with 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]**

Q5) a) State and prove Liouville's theorem. **[4]**

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

c) The system has two states of energy E_1=0J and E_2=10^{-22}J. Find the probabilities P_1 and P_2 for the system to be in states 1 and 2 respectively, when the mean energy of the system is 0.2 E_2. Assuming Boltzmann distribution. Calculate the Bose temperature. **[3]**

Q6) a) When the chemical potential $\mu = 0$, Show that Bose temperature is

$$T_b = \frac{h^2}{2\pi mK}\left[\frac{N}{2.612}\right]^{2/3}$$ **[4]**

b) State and prove Equipartition theorem. **[3]**

c) The molar mass of lithium is 0.00694 and its density is 0.53×10^3 kg/m^3. Calculate the Fermi energy and Fermi temperature of the electron. **[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 $\frac{\Delta * E}{\bar{E}} = \frac{1}{\sqrt{\exists}}$ **[5]**

b) Consider an ideal monatomic gas of N mole enclosed in volume V. Show that the number of accessible states of free energy interval between E and E + δE is expressed in the form Ω (E) = BVN $E^{3N/2}$, Where B is constant independent of E and V. **[5]**

Q8) a) Obtain Maxwell - Boltzmann velocity distribution and hence show that the root mean square velocity, V_{rms}, mean velocity $\bar{v}$ and most probable velocity $\bar{v}$ are in the ratio

$$V_{rms} : \bar{v} : \tilde{v} = \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$$ **[5]**

b) Show that the Fermi energy of Fermions is $\in_F = \frac{\hbar^2}{2m}\left(\frac{3\pi^2 N}{V}\right)^{2/3}$ **[5]**

Total No. of Questions : 8]

SEAT No. :

P1292

[Total No. of Pages : 4

[5122] - 3002
M.Sc. (Semester - III)
PHYSICS
PHYUT-702: Quantum Mechanics - II
(2013 Pattern) (4 Credits) (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 calculators allowed.***

Q1) a) Using WKB approximation, show that energy of linear harmonic oscillator is $E = (n + \frac{1}{2})\ \hbar w$. **[4]**

b) Explain electrical dipole transitions in detail. **[3]**

c) For the rigid sphere of radius a, show that the scattering cross-section is given by $\sigma = 4\ \pi\ a^2$. **[3]**

Q2) a) Using partial wave analysis show that the total scattering cross- section is given by $\sigma = \frac{4\pi}{K^2}\sum_{l=o}^{\infty}(2l+1)\sin^2\delta_l$ **[4]**

b) Interpret the concept of identical particles. Explain parity. **[3]**

c) Show that state effect in ground state of hydrogen atom is zero. **[3]**

Q3) a) Discuss schrödinger and Heisenberg picture in quantum mechanics. **[4]**

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

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

Q4) a) Discuss time dependent perturbation theory. Obtain expression for first order transition amplitude. **[4]**

b) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$, where α is variational parameter, obtain ground state energy of anharmonic oscillator with $H = \frac{P^2}{2m} + \lambda x^3$ **[3]**

c) Explain discrete lattice translations. **[3]**

P.T.O.

Q5) a) Consider potential of the form $V(r) = V_o e^{-r^2/a^2}$. Calculate, using Born approximation, the differential cross - section. **[4]**

b) State and explain Pauli's exclusion principle for system of two fermions. **[3]**

c) What is variational method? Show that it gives an upper bound to the ground state energy. **[3]**

Q6) a) Obtain slater determinant for system of N - particles. **[4]**

b) Show that

$$tan\theta_o = \frac{\sin\theta}{\frac{m_1}{m_2} + cos\theta}$$

Where θ_o and θ are scattering angles in laboratory and centre of mass frame respectively. **[3]**

c) Obtain expression for transmission probability through potential barrier by using WKB approximation. **[3]**

Q7) a) What is harmonic perturbution? Obtain expression for transition probability. **[5]**

b) Explain Ramsauer - Townsend effect in scattering. **[5]**

Q8) a) Using variation method, obtain ground state energy of hydrogen atom by using trial wave function $\psi(r) = Ae^{-\alpha r}$, where α is variational parameter. **[5]**

b) State and explain Fermi Golden rule. **[5]**

Total No. of Questions : 8]

P1292

[5122] - 3002
M.Sc. (Semester - III)
PHYSICS
PHYUT-702: Physics of Semiconductor Devices
(2013 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Q1) a) Derive an expression of maximum electric field and the diffusion capacitance of the linearly graded junction. **[4]**

b) Use poisson's equation and derive built - in potential of the JFET. **[3]**

c) Write a note on narrow base diode. **[3]**

Q2) a) Deduce the equation of diffusion capacitance of p-n junction at low frequency and show its variation with increase in frequency. **[4]**

b) Describe the significance of the Gummel number. **[3]**

c) Explain switching mechanism of BJT. **[3]**

Q3) a) Define generation and recombination current density. Also find the total forward current density (J_F). **[4]**

b) In metal semiconductor contact, explain any one method of measuring barrier height in detail. **[3]**

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

Q4) a) Draw characteristics of power transistor and explain the avalanche and second breakdown of the power transistor. **[4]**

b) What is the pinch-off and saturation mechanism of JFET? **[3]**

c) A Si sample is doped with 2.70×10^{16} atoms/cm^3 donor atoms. What is the equilibrium hole concentration at 300 k?

Given: $n_i = 1.5 \times 10^{10} cm^{-3}$ **[3]**

Q5) a) A Si sample doped with donors at 10^{17} cm^{-3}. If the intrinsic concentration within Si is $10^{10} cm^{-3}$, determine the location of the fermi level relative to valence band.

Given: $m_e^* = 0.382$, $m_h^* = 0.55$. **[4]**

b) Discuss different interface states of metal-semiconductor contact. **[3]**

c) Prove that $J_n = \mu_n . n \nabla E_{Fn}$ **[3]**

Q6) a) Consider an abrupt Si p-n junction in equilibrium. Assume that the acceptor and donor concentrations are 1×10^{18} cm^{-3} and $1 \times 10^{16} cm^{-3}$ respectively. Determine the built - in voltage.

Given : $n_i = 1.5 \times 10^{10}$ cm^{-3}, kT = 0.0259V. **[4]**

b) Describe the impact ionization with suitable diagram. **[3]**

c) What is Schottky barrier? Compare the Rectifying and Ohmic contact. **[3]**

Q7) a) Explain the construction and I-V characteristics of SCR. How the triggering mechanism occurs in SCR? **[5]**

b) What is the IMPATT diode? Describe the avalanche and drift region of the IMPATT diode. **[5]**

Q8) a) State the assumptions of thermionic emission theory of metal semiconductor contact and find the equation of total current density. **[5]**

b) Draw

i) Connection and current components in common base configuration

ii) Doping profile and

iii) Energy band diagram of n - p - n transistor. Also, define the emitter injection efficiency, base transport factor and common base current gain. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1293 **[Total No. of Pages : 3**

[5122] - 4001
M.Sc. (Physics) (Semester - IV)
PHY UT-801: NUCLEAR PHYSICS
(2014 Pattern) (4 Credits)

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

Instructions to the candidates:

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

Q1) a) For energy filters in mass spectrometers, show that $\frac{1}{2}mv^2 = \frac{neVRo}{2d}$, where symbols have usual meaning. **[4]**

b) What is the distance of closest approach of a 2 MeV proton to a gold nucleus. How does this distance compare with those for a deuteron & an α- particle of the same energy. [Given Z for gold = 79, e=1.6×10^{-19}C, $1/4\pi\ \varepsilon o = 9\times10^9\ Nm^2/C^2$] **[3]**

c) Find the energy release if two $_1{}^2H$ nuclei can fuse together to form $_2{}^4He$ nucleus. The binding energy per nucleon of $_1{}^2H$ and $_2{}^4He$ is 1.1 MeV & 7.00 MeV respectively. **[3]**

Q2) a) Explain stability of electron with the help of Fermi gas model. **[4]**

b) Explain High purity germanium detector **[3]**

c) What are the achievements & failures of shell model. **[3]**

Q3) a) Show that for microtron $\Delta E = \frac{E_o\gamma}{\mu - \gamma}$. **[4]**

b) Explain the mechanism of controlled chain reaction. **[3]**

c) Explain the various conditions of criticality of nuclear reactors. **[3]**

P.T.O.

Q4) a) What are the various conservation laws in elementary particle physics. **[4]**

b) Compute the maximum energy of the compton recoil electrons resulting from the absorption in Al of 2.19 MeV γ–ays. (Rest mass of e^{-}=9.1×10^{-31}kg) **[3]**

c) Calcualate the total cross section for np scattering of neutrons having energy 2MeV **[3]**

$$a_t = 5.38\,\text{F} \quad a_s = 23.4\,\text{F}$$
$$\gamma_{ot} = 1.70\,\text{F} \quad \gamma_{os} = 2.40\,\text{F}$$

Q5) a) What are quarks? Explain how quarks are treated as building blocks of Hadrons & mesons. **[4]**

b) Which of the following reactions are allowed or forbidden under conservation of strangeness, baryan number & charge. **[3]**

$$\pi^{+} + n \longrightarrow \Lambda^{\circ} + \kappa^{+}$$
$$\pi^{-} + \rho \longrightarrow \pi^{\circ} + \Lambda^{\circ}$$

c) Derive an expression for four factor formula. **[3]**

Q6) a) What is accelerator? Explain construction, & working of van - de graff accelerator. **[4]**

b) In a certain betatron the maximum field was 4000 gauss operating at 50 cycle/sec with a stable orbit diameter of 60. inches. Calculate the average energy gained per revolution. Also calculate the final energy of the electrons. **[3]**

c) Write a note on graphite moderated research reactor. **[3]**

Q7) a) Explain the construction & working of Na I (Tl) scintillation detector. **[5]**

b) Explain magnetic dipole moment S.T for the nucleus of mass no 'A' the magnetic dipole moment is.

$$\bar{\mu} = \frac{\mu_o e}{2m}\left[\sum_{K=1}^{A} g_s \bar{S}k + \sum_{K=1}^{Z} g_l \bar{L}k\right]$$ **[5]**

Q8) a) Derive an expression for threshold energy of the projectile. **[5]**

b) Explain np scattering at low energy & obtain the expression for the total elastic scattering cross section. **[5]**

Total No. of Questions : 8] **SEAT No. :**

P1294 **[Total No. of Pages : 2**

[5122] - 4002
M.Sc. (Physics) (Semester - IV)
PHYUT-802: MATERIAL SCIENCE
(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 tables & calculators is allowed.***

Given:

Avogadro's number = 6.0225×10^{26} (kilo mole)$^{-1}$

Boltzmann constant = 1.3805×10^{-23} JK^{-1}

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

b) Draw a Burger circuit around a possitive edge dislocation and determine its Burger vector. **[3]**

c) Make two neat sketches to show the climbing up and climbing down of an edge dislocation. What happens to the vacancy concentration in the crystal during each process? **[3]**

Q2) a) Calculate the spacing between dislocations in a tilt boundary in FCC crystal When angle of tilt is 2°. **[4]**

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

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

Q3) a) Explain fick's First and second low of diffusion. **[4]**

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

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

P.T.O.

Q4) 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) Explain binary phase diagram in brief. **[3]**

c) State lever rule. Explain with an illustration how it is useful in determination. for weight fractions of liquid and solid. **[3]**

Q5) a) Explain five different invarient equations with the help of neat diagram. **[4]**

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

c) Explain the condition for the solution to be exmibit a Raoultion ideal solution. **[3]**

Q6) a) Derive the expression for energy of an edge dislocation by using the geometrical mode. **[4]**

b) Explain the mechanism of generation of multiple dislocations during deformation by using frank -Read source. **[3]**

c) Explain vegard's law for solid solution. **[3]**

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

b) An Aluminium crystal has a dislocation density of 10^{10} m^{-2}. The shear modulus of aluminium is 25.94 GNm^{-2}. Calculate the elastic energy of line imperfection stored in the crystal. Given:a = 4.05A. **[5]**

Q8) a) Estimate the shift of the electron cloud with respect to the nucleus in a Xenon (Xe) atom, when a field of 10^5 V m^{-1} is applied (Atomic number of xe = 54, Electronic polarizability of Xe=3.54 $\times 10^{-40}$F m^2. **[5]**

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