Total No. of Questions : 7]

SEAT No. :

P2086

[Total No. of Pages : 3

[4822]-11
M.Sc.
PHYSICS
PHY UTN - 501 : Classical Mechanics
(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory and solve ANY FOUR questions from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of Logarithmic table and electronic calculator is allowed.***

Q1) Attempt any Four of the following:

a) Using variational principle, obtain the equation of motion for stable equilibrium configuration of a uniform heavy flexible string fixed between two points A(x_1, y_1) and B(x_2, y_2) in the constant gravity field of the earth. **[4]**

b) Prove the distribution law: **[4]**

[F, G+K] = [F, G] + [F, K] for Poisson bracket.

c) Describe Hamiltonian and Hamiltonian equation of motion for Ideal spring mass arrangement. **[4]**

d) Discuss a two body problem into equivalent one body problem. Hence, explain the concept of reduced mass. **[4]**

e) A cylinder of radius 'a' and mass 'm' roles down on an incline plane making an angle 'θ' with horizontal. Set up Lagrangian and find the equation of motion. **[4]**

f) Show that the transformation **[4]**

P = q cot p

$Q = \log\left(\frac{\sin p}{q}\right)$ is canonical.

P.T.O.

Q2) a) State the condition for canonical transformation. For what values of 'm' and 'n' the following equation represents canonical transformation. **[8]**

$P = q^m \sin np$

$Q = q^m \cos np$

Also obtain the generating function.

b) What is Focault's pendulum? Obtain an equation of motion for such a pendulum. **[8]**

Q3) a) Show that for a relativistic free particle, Hamiltonian is expressed as **[8]**

$$H(\bar{r}, p) = \sqrt{p^2c^2 + m_0^2 C^4} + V(r)$$

b) Evaluate the Poisson's bracket's **[8]**

i) $[L_x, x]$

ii) $[L_x, P_x]$

Q4) a) What are configuration space and phase space. Draw phase space diagram for **[8]**

i) Damped and undamped harmonic oscillator.

ii) A stone thrown vertically up in the field of uniform gravity.

b) Explain Brachistochrone problem. **[8]**

Q5) a) An inextensible string of neglible mass hanging over a smooth peg connects one mass m_1 on a frictionless inclined plane of angle θ to another mass m_2. Using D'Alembert's principle obtain equation of motion and prove that the masses will be in equilibrium if $\sin \theta = \frac{m_2}{m_1}$. **[8]**

b) Obtain differential equation of orbit in the form **[8]**

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

where, $u=\frac{l}{r}$, l is the angular momentum and f(r) is central force.

Q6) a) Show that, the geodesic of spherical surface are great circle i.e. the circles having centers at the center of the sphere. **[8]**

b) A particle moving in a central force field located at r = 0, describes a spiral $r=e^{-\theta}$. Prove that the magnitude of force is inversely proportional to r^3. **[8]**

Q7) a) The transformation equations between two sets of coordinates are **[8]**

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

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

Show that the transformation are canonical. Also show that the function which generates these transformation is

$F_3 = -(e^Q - 1)^2 \tan p.$

b) Deduce the Lagrangian function and Lagrange's equation of motion for a compound pendulum. Also calculate the period of its oscillation. **[4]**

c) A particle moves with velocity in an elliptical path in an inverse fixed.**[4]**

Prove that $v^2=\frac{k}{\mu}\left[\frac{2}{r}-\frac{1}{a}\right]$.

Total No. of Questions : 7]

SEAT No. :

P2087

[Total No. of Pages : 3

[4822]-12
M.Sc.
PHYSICS
PHY UTN - 502 : Electronics
(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory and solve any <u>FOUR</u> questions from the remaining.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) Attempt any <u>FOUR</u> of the following:

a) Draw block diagram of OPAMP. Explain function of each block. **[4]**

b) Define CMRR and slew rate. State its ideal and real value for IC 741. **[4]**

c) Draw circuit diagram for monostable multivibrator using IC 555. Explain its operation. **[4]**

d) Draw circuit diagram of first order active low pass filter. Draw its frequency responce. How it can be improved? **[4]**

e) Draw internal block diagram of 3-pin voltage regulator. Explain function of each block. **[4]**

f) Design 4:1 multiplexer using NAND gates only. **[4]**

Q2) a) Draw internal block diagram of IC 7495. Explain its operation with reference to truthtable. How it can be used as SISO, SIPO, PISO and PIPO register? **[8]**

b) Draw circuit diagram of 2-OPAMP function generator. Explain its operation. Derive formula for its output frequency. How its parameters can be varied? **[8]**

P.T.O.

Q3) a) Draw circuit diagram for 4-bit binary ladder type DAC. Derive expression for analog output voltage.

Determine its analog outputs if digital input given is **[8]**

i) 1010 and

ii) 0111.

(Given : Logic O = OV, Logic 1 = 16V).

b) Draw internal block diagram of IC 8038. Explain its working. Derive expression for its output frequency. Design a function generator using IC 8038 to generate output frequency of 10KHz with adjustable duty cycle using single resistor. **[8]**

Q4) a) Draw block diagram of 4-bit synchronous UP/DOWN counter. Explain its operation. State its applications. **[8]**

b) What is VCO? Draw internal block diagram of IC 566. Derive expression for its output frequency. Design an oscillator using IC 565 to produce output frequency adjustable from 1kHz to 20kHz. **[8]**

(Given : $V_{CC} = \pm$ 10V)

Q5) a) Sketch circuit diagram for full-wave precision rectifier. Derive equation for its output voltage. Explain its operation. State its applications. **[8]**

b) Draw internal block diagram of IC 7490. How it can be used as MOD7 counter with and without using additional logic gate. **[8]**

Q6) a) Draw general block diagram of PLL. Explain its operation. Determine the free-running frequency, capture range and lock range for PLL designed using IC 565 with $R_1 = 10\ K\Omega$, $C_1 = 0.033\ \mu F$, $C_F = 10\ \mu F$, $V_{CC} = \pm$ 10V. **[8]**

b) Draw circuit diagram of 3-bit flash ADC. Explain its operation. State its advantage and disadvantages. **[8]**

Q7) Write short note on any FOUR of the following: **[4 each]**

a) Successive approximation ADC.

b) Sample - hold amplifier.

c) DC-DC converter.

d) Switch mode power supply.

e) Programmable Logic Array.

f) Satellite Communication.

Total No. of Questions : 7]

SEAT No. :

P2088

[Total No. of Pages : 3

[4822]-13
M.Sc.
PHYSICS
PHY UTN - 503 : Mathematical Methods in Physics
(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question no.1 is compulsory.***
2) ***Attempt <u>any four</u> out of the remaining Questions.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculators is allowed.***

Q1) Attempt any <u>four</u> of the following: **[16]**

a) Find if the following set of vectors in dependent or independent

i) $v_1 = (2,1,0,3)$,

ii) $v_2 = (3,-1,5,2)$,

iii) $v_3 = (-1,0,2,1)$

b) Define spherical Harmonic function $Y_e^m(\theta,\phi)$. Write the orthogonality integral for it.

c) The Rodrigue's formula for Laguerre polynomial is $L_n(x) = \frac{e^x}{n!}\frac{d^n}{dx^n}(x^n e^{-x})$. Using this generate $L_0(x)$, $L_1(x)$ and $L_2(x)$.

d) Prove that $f(z) = z^2$ is analytic function of z at (0, 0).

e) If H is Hermitian show that e^{iH} is unitary and if e^{iH} is unitary. H is Hermitian.

f) Show that $L\{e^{at} F(t)\} = f(s - a)$.

P.T.O.

Q2) a) Evaluate using Cauchy's Integral theorem. **[8]**

$\int_C x^2 - y^2 + 2ixy)dz$ where C is the contour $|z| = 1$

b) Applying calculus of residues prove. **[8]**

$$\int_0^{2a} \frac{\cos 2\theta}{5+4\cos\theta} d\theta = \frac{\pi}{6}.$$

Q3) a) Let V be a vector space of ordered pairs of real numbers $V = \{(a, b) : a, b \in R\}$. Show that V is not a vector space if. **[8]**

i) $(a, b) + (c, d) = (a + c, b + d)$, $k(a, b) = (k, 0)$

ii) $(a, b) + (c, d) = (0, 0)$, $k(a, b) = (ka, kb)$

b) State and prove Cauchy-Schwarz inequality. **[8]**

Q4) a) Consider following linear operator T on R^3. **[8]**

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

i) T is invertible

ii) Find T^{-1}.

b) Find eigenvalues and eigen vectors of **[8]**

$$\begin{bmatrix} -1 & 4 & -2 \\ -3 & 4 & 0 \\ -3 & 1 & 3 \end{bmatrix}$$

Q5) a) Define adjoint of an operator. When is the operator self-adjoint? Show that for self-adjoint operator the eigenvalues are real. **[8]**

b) Write the generating function for Hermite polymomials and prove that

$H_{n+1}(x) = 2x\, H_n(x) - 2nH_{n-1}(x)$

and $H_n^1(x) = 2n\, H_{n-1}(x)$. **[8]**

Q6) a) Expand $f(x)$ as a Fourier Series. **[8]**

$f(x) = x \qquad 0 < x < \pi$

$= -x \qquad -\pi < x < 0$

b) Find the Laplace transform of **[8]**

i) $L\{6\sin 2t - 5\cos 2t\}$

ii) $L\{e-4t \cos h2t$

Q7) a) For Bessel's function show that

$$\frac{d}{dx}\left[x^n J_n(x)\right] = x^n J_{n-1}(x)$$ **[4]**

b) Define associated Legendre function $P_n^m(x)$. Write the parity and orthogonality relations for $P_n^m(x)$. **[4]**

c) Determine if the following matrices are Hermitian. **[4]**

i) $\begin{bmatrix} 2 & 4-i \\ 4+i & 1 \end{bmatrix}$

ii) $\begin{bmatrix} 3 & 2+i \\ 2+i & 4 \end{bmatrix}$

d) Write **[4]**

i) $u = 3t^2 + 8t - 5$ and

ii) $u^1 = 4t^2 - 6t - 1$

as a linear combination of the vectors.

$v = 2t^2 + 3t - 4$ and $w = t^3 - 2t + 3$

Total No. of Questions : 7]

SEAT No. :

P2089

[Total No. of Pages : 2

[4822]-14
M.Sc.
PHYSICS
PHYUT - 504 : Quantum Mechanics - I
(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory.***
2) ***Attempt any four questions from the remaining.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of calculator is allowed.***

Q1) Attempt any four of the following:

a) Show that even if an operator A is not self-adjoint, $(A^{+}A)$ is always self-adjoint. **[4]**

b) Show that momentum operator is hermitian. **[4]**

c) Show that $[J_{+}, J] = 2\hbar J_{z}$. **[4]**

d) For Pauli spin matrices, show that **[4]**

$$\sigma_x\sigma_y = i\sigma_z \text{ and } \sigma_x^{\,2} + \sigma_y^{\,2} + \sigma_z^{\,2} = 3$$

e) Show that eigen vectors belonging to different eigen values of a hermitian operator are mutually orthogonal. **[4]**

f) For a simple harmonic oscillator, show that $[P, H] = -i\hbar mw^2x$. **[4]**

Q2) a) State and explain the four fundamental postulates of quantum mechanics. **[8]**

b) In the Dirac formulation of quantum mechanics, explain the following terms: **[8]**

i) State vectors.

ii) Norm and scalar product.

iii) Basis in Hilbert space.

P.T.O.

Q3) a) Obtain the eigen values of a simple harmonic oscillator using ladder operators. **[8]**

b) Obtain the Clebsch-Gordon co-efficients for a two particle system with $j_1 = j_2 = ½$. **[8]**

Q4) a) Obtain the eigen values and eigen functions of a momentum operator. **[8]**

b) Compare Schrödinger and Heisenberg pictures of time evolution. **[8]**

Q5) a) State expansion postulate and show that eigen functions belonging to discrete eigen values are normalizable. **[8]**

b) Obtain the eigen values of L^2 and L_z operators. **[8]**

Q6) a) Obtain the matrices for J_x, J_y, J_z and J^2 operators in the $|jm\rangle$ basis for $j = ½$. **[8]**

b) Define projection operator. Hence show that it is a unit operator. **[8]**

Q7) a) Use uncertainty principle to estimate the ground state energy of hydrogen atom. **[4]**

b) Explain the concept of degenerate states and non-degenerate states. **[4]**

c) Show that angular momentum operator is the generator of infinitesimal rotations. **[8]**

Total No. of Questions : 7]

SEAT No. :

P2090

[Total No. of Pages : 3

[4822]-21
M.Sc.
PHYSICS
PHY UTN - 601 : Electrodynamics
(2008 Pattern) (Old Course) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Attempt any four questions from the remaining.***
2) ***Draw neat labeled diagrams wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of logarithmic tables & calculator is allowed.***

Q1) Attempt any four of the following:

a) Show that the ratio of electrostatic & magnetostatic energy densities $\left(\frac{\mu_e}{\mu_m}\right)$ is equal to unity. **[4]**

b) Find the phase velocity of a plane wave at a frequency 10GHz in polyethelene material. **[4]**

Given - $\mu_0 = \mu = 4\pi \times 10^{7}$N/A

$\in_r = 2.3$

$\sigma = 2.56 \times 10^{-4}$ mho/m

$\in_0 = 8.85 \times 10^{-12} \frac{\text{coulomb}^2}{\text{N} - \text{m}^2}$.

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

d) Write Maxwell's equation in differential and Integral form. **[4]**

P.T.O.

e) Show that another point form of Faraday's law is $\therefore \vec{E} = -\frac{\partial \vec{A}}{\partial t}$

where, $\vec{A}$ is magnetic potential. **[4]**

f) An electron is moving at a speed of 1.8×10^8m/s. Find the ratio of its effective mass to its rest mass. **[4]**

Q2) a) What is linear quadrupole? Derive an expression for potential at a distant point due to a small linear quadrupole. **[8]**

b) Derive the Lorentz relativistic transformation equations. **[8]**

Q3) a) State & prove Poynting's theorem. **[8]**

b) Show that $C^2B^2 - E^2$ & $\vec{E} \cdot \vec{B}$ are invariant under Lorentz transformation. **[8]**

Q4) a) Starting from Maxwell's equation, derive in homogeneous wave equation in terms of scalar potential ϕ & vector potential $\vec{A}$. **[8]**

b) Define Hertz Dipole vector. Using potential for dipole, obtain radiation dipole field which is given by: **[8]**

$$E_\theta = \frac{\sin\theta}{4\pi \in_0} \frac{e^{iKR}}{R} \left[\left(\vec{P}_1 \times \vec{K} \right) \times K \right]$$

Q5) a) The magnetic field intensity $\vec{B}$ at a point is given by: $\vec{B} = \left(\frac{\mu_0}{4\pi} \right) \int \frac{\vec{j} \times \vec{r}}{r^3} d\tau$

show that $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ **[8]**

b) A plain e.m. wave is incident obliquely on an interface between two non-conducting dielectric media. Obtain an expression for Fresnel's equation if the electric field vectors are perpendicular to the plane of incidence. **[8]**

Q6) a) Explain the term 'Electromagnetic field tensor'. Hence obtain an expression for e.m. field tensor $F_{\mu\nu}$. **[8]**

b) Obtain Faraday's law of induction in differential form for a stationary medium & show how it can be modified if the medium is moving with velocity $\vec{\mu}$. **[8]**

Q7) Write notes on <u>any Two</u> of the following: **[16]**

a) Boundary conditions on $\vec{E}\&\vec{B}$, $\vec{D}\&\vec{H}$ at the interface between two media.

b) Law of relativistic addition of velocities.

c) Minkowsky Force.

d) Four vector potential.

Total No. of Questions : 7]

SEAT No. :

P2091

[Total No. of Pages : 2

[4822]-22
M.Sc.
PHYSICS
PHY UTN - 602 : Atoms, Molecules and Solids
(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Q.No.1 is compulsory, solve any four questions of the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of Logarithmic table and electronic pocket calculator is allowed.***

Given:

Rest mass of electron	=	9.901×10^{-31} kg
Charge on electron	=	1.6021×10^{-19} coulomb
Planck's constant	=	6.626×10^{-34} Js
Boltzmann constant	=	1.38054×10^{-23} JK^{-1}
Avogadro's number	=	6.022×10^{-26} $(Kmole)^{-1}$
Bohr Magneton	=	9.27×10^{-24} $amp.m^2$
1eV	=	1.6021×10^{-19} J

Q1) Attempt any four of the following:

a) The Zeeman splitting of 500nm spectral line when a magnetic field of 0.4T is applied is observed as 0.015 nm. Find e/m. **[4]**

b) Calculate Lande g factor for $^3D_3$ state. **[4]**

c) The value of Xe for lower and upper states of C_2 are 0.0071 and 0.00919 respectively. Find number of levels in upper and lower states. **[4]**

d) The concentration of Schottky defects in an ionic crystal is 1 in 10^{10} at a temperature of 300K. Calculate the activation energy for the formation of Schottky defect. **[4]**

e) What is the nuclear g_N factor for ^{19}F nucleus which has magnetic moment of 2.6273 μ_N. Nuclear spin Q.no. I = ½. **[4]**

f) A free electron is placed in a magnetic field of strength 1.3T calculate the resonance frequency if g = 2.0023. **[4]**

P.T.O.

Q2) a) Define atomic scattering factor and show that its maximum value is equal to the atomic number Z of the atom. **[8]**

b) Derive the expression for temperature dependance of the concentration of Schottky defects in an ionic crystal. **[8]**

Q3) a) Derive the relation between W and K for vibrational modes in 1-D monoatomic lattice of identical atoms. **[8]**

b) What are the limitations of classical theory of specific heat? Derive expression for specific heat of solids on the basis of Einstein model. **[8]**

Q4) a) In the context of rotational fine structure of electronic vibrational spectra explain band origin and band head. **[8]**

b) Write note on vibrational coarse structure explaining γ' progration. Draw neat diagrams. **[8]**

Q5) a) Explain the principle of NMR. Explain the working of typical NMR spectrometer and write its applications. **[8]**

b) State and explain Frank-Condon principle. **[8]**

Q6) a) Distinguish between Normal and Anomalous Zeeman effect. Explain why anomalous Zeeman effect is observed only in atoms with odd number of electrons. **[8]**

b) Write note on: **[8]**

i) Screw dislocation and

ii) Edge dislocation.

Q7) a) Obtain the expression for configurational entropy. **[4]**

b) Explain the concet of phonon and quantization of elastic waves. **[4]**

c) What are normal and Umklapp processes. **[4]**

d) Write short note on Interstitial and Substitutional solid solutions. **[4]**

Total No. of Questions : 7]

SEAT No. :

P2092

[Total No. of Pages : 3

[4822]-23
M.Sc.
PHYSICS
PHY UTN - 603 : Statistical Mechanics in Physics
(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory, solve any four questions of the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of Logarithmic tables and electronic pocket calculator is allowed.***

Constrants:

1) ***Boltzmann constant*** K_B = $1.38 \times 10^{-23} J/K$
2) ***Gas constant R*** = ***1.987 cal/deg./mole***
3) ***Planck's constant h*** = 6.625×10^{-34} ***J-sec.***
4) ***Avogadro's number N*** = 6.023×10^{23} ***/gm–mole***
5) ***Mass of electronme*** = 9.1×10^{-31} ***kg***

Q1) Attempt any 4 of the following:

a) For a mole of gas at NTP condition, calculate the molar heat capacity at constant volume. **[4]**

b) Obtain the phase space trajectory of a simple harmonic oscillator. **[4]**

c) Obtain the entropy relation $S = k\left[\ln Z + \beta \bar{E}\right]$. **[4]**

d) The atomic weight of Lithium is 6.94 and its density is 0.53gm/cm^3. Calculate the Fermi energy and Fermi temperature of the electrons. **[4]**

e) Calculate the average kinetic energy of neutrons at 300ºK. **[4]**

f) A system of 3 particles has energy levels with energies 0, 1, 2, 3 units. The total energy of the system is 3 units. List the accessible microstates if the particles are **[4]**

i) indistinguishable

ii) distinguishable

P.T.O.

Q2) a) For grand canonical ensemble, show that the probability of finding the system in a particular microstate *r* having energy E_r and number of particles N_r is given by

$$P_r = \frac{e^{-\beta E_r} - \alpha N_r}{\sum_r e^{-\beta E_r - \alpha N_r}}$$ **[8]**

b) Write the partition function of Bose-Einstein statistics and hence obtain Bose-Einstein distribution in the form. **[8]**

$$\bar{n}_s = \frac{1}{e^{\beta(E_s - \mu)} - 1}$$

Q3) a) Show that for classical monatomic ideal gas having N particles contained in volume V, the number of states $\Omega(E)$ for the system in teh energy range E to E + δE is given by $\Omega'(E) = BV^N E^{3N/2}$. **[8]**

b) Derive the excpression for Stefan's law in case of black body radiation. **[8]**

Q4) a) For a system in contact with heat reservior (Canonical ensemble), show that the probability of finding the system in a particular microstate *r* with energy E_r is given by

$$P_r = \frac{e^{-\beta E_r}}{\sum_r e^{-\beta E_r}}$$ **[8]**

b) Using Canonical distribution, obtain the law of atmosphere. **[8]**

Q5) a) State and prove Liouville's theorem. **[8]**

b) Derive an expression for compressibility of Fermi gas at absolute zero temperature. **[8]**

Q6) a) What is black body radiation? Show that radiation pressure is equal to one third of the energy density. **[8]**

b) Obtain Curie law of paramagnetism, on the basis of canonical ensemble. **[8]**

Q7) a) Show that the energy fluctuation in canonical distribution is given by $\overline{\Delta E^2} = KT^2 C_v$ **[4]**

b) What do you mean by mechanical and thermal interactions? **[4]**

c) Obtain the expression for mean energy of fermions at T = 0°K. **[4]**

d) Write a short note on phase space. **[4]**

Total No. of Questions : 7]

SEAT No. :

P2093

[Total No. of Pages : 3

[4822]-24
M.Sc.
PHYSICS
PHYUTN - 604 : Quantum Mechanics - II
(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory.***
2) ***Attempt any four of the remaining.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of calculator is allowed.***

Q1) Attempt any four of the following:

a) Use Born approximation to show that scattering amplitude is the Fourier transform of the potential. **[4]**

b) Show that the variation method gives an upper bound to the ground state energy. **[4]**

c) Show that for two colliding particles of masses m_1 and m_2, the total energies in the laboratory frame and the centre of mass frame are related by $E_{cm} = \frac{\mu}{m_1} E_{lab}$, where μ is the reduced mass of the system of particles. **[4]**

d) Show that the stark effect for the ground state of hydrogen atom is absent in the first order of time independent perturbation theory. **[4]**

e) In an elastic collision between two particles of equal mass, show that the two particles come out at right angles to each other in the laboratory frame of reference. **[4]**

f) Write the connection formulae across the turning points with positive and negative slopes. **[4]**

P.T.O.

Q2) a) Using the first order time dependent perturbation theory, obtain Fermi's golden rule for constant perturbation. **[8]**

b) Obtain the ground state energy of hydrogen atom using a trial wave function $\psi(r) = Ae^{-r/a}$, where 'a' is a variational parameter. **[8]**

Q3) a) Using WKB approximation, obtain the transmission probability for α-particle decay. **[8]**

b) Obtain an expression for the scattering amplitude for the Yukawa potential in the Born approximation. **[8]**

Q4) a) Show that degeneracy is removed in the first order of the time independent perturbation theory. **[8]**

b) Use phase shift analysis to obtain an expression for the scattering amplitude at low energies by a rigid sphere. **[8]**

Q5) a) Discuss the classical and quantum mechanical pictures of collision between identical particles. Obtain the differential scattering cross-sections in the two cases. **[8]**

b) Obtain an expression for the first order transition amplitude for harmonic perturbation. **[8]**

Q6) a) Define symmetric and antisymmetric wave functions. Hence obtain the slater determinant for a system of N identical antisymmetric functions. **[8]**

b) Obtain the correction to the energy eigen values of an anharmonic oscillator with $H = \frac{p^2}{2m} + \frac{1}{2}mw^2x^2 + \lambda x^4$, using first order time independent theory. **[8]**

Q7) a) Explain the conditions of validity of the Born approximations. **[4]**

b) Discuss the selection rules for transitions in an atom. **[4]**

c) Reduce the Hamiltonian of a two particle quantum mechanical system to that of a single particle system. **[4]**

d) Define differential scattering cross-section and obtain its relation with the scattering amplitude. **[4]**

Total No. of Questions : 7]

SEAT No. :

P2094

[Total No. of Pages : 3

[4822]-31
M.Sc.
PHYSICS
PHY UTN - 701 : Solid State Physics
(2008 Pattern) (Old Course) (Semester - III)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Q. No.1 is compulsory and solve any Four questions from the remaining.***
2) ***Figures to the right indicate full marks.***
3) ***Draw neat labelled diagrams wherever necessary.***
4) ***Use of logarithmic table and pocket calculator is allowed.***

Given:

Rest mass of electron	=	9.109×10^{-31} kg.
Charge of electron	=	1.602×10^{-19} C
Plank's constant	=	6.626×10^{-34} J-S
Boltzmann constant	=	1.38×10^{-23} JK^{-1}
Avogadro's number	=	6.023×10^{23}/mole
Bohr magneton	=	9.27×10^{-24} $A\text{-}m^2$
Permeability of free space	=	$4\pi \times 10^{-7}$ H/m
Permittivity of free space	=	8.85×10^{-12} $C^2/N\text{–}m^2$

Q1) Attempt any four of the following: **[16]**

a) A given superconductor has critical Fields 1.4×10^5 and 4.2×10^5 A/m at 14 K and 13K respectively. Calculate its transition temperature and critical field at 4.2 K.

b) The density and atomic number of niobium are 8.57×10^3 kg/m^3 and 93 respectively. It has one conduction electron per atom. Calculate London penetration depth of niobium.

c) Determine the value of Fermi function for an energy KT above the Fermi energy.

P.T.O.

d) Sodium metal with b_{cc} structure has two atoms per unit cell. The radius of the sodium atom is $1.85\,\mathring{A}$. Estimate the order of diamagnetic susceptibility.

e) The dipole moment of a hydrogen chloride molecule is 3.3×10^{-30}C-m. Determine the actual amount of charge transfer from the hydrogen to chlorine atom wher the seperation between chlorine nuclei is $1.28\,\mathring{A}$.

f) Show that for a simple square lattice the kinetic energy of free electron at a corner of the first Brillouin zone is higher than that of electron at mid point of side face of the zone by a factor of 2.

Q2) a) Explain the origin of diamagnetism in a free atom. Derive Langevin formula for diamagnetic susceptibility. **[8]**

b) Derive London equation for superconducting state and obtain an expression for penetration depth. **[8]**

Q3) a) Discuss the term Anisotropy energy and Bloch wall with referrence to ferromagnetism. **[8]**

b) Explain the phenomenon of paramagnetism. Derive an expression for paramagnetic susceptibility using Langevin theory. **[8]**

Q4) a) On the basis of Kronig-Penney model, show that the energy spectrum of an electron consists of alternate regions of allowed and forbidden energy bands. **[8]**

b) Explain the paramagnetism in rare earth ions and iron group ions on the basis of quenching of orbital angular momentum. **[8]**

Q5) a) Explain the formation of energy gap on the basis of nearly Free electron model. **[8]**

b) Write a note on type-I and type-II superconductors. **[4]**

c) Explain Meissner effect in superconductors. **[4]**

Q6) a) Define dielectric function of the free electron gas and derive an expression for plasma frequency. **[8]**

b) Write a note on ferroelectricity and ferroelectric crystals with reference to $BaTiO_3$. **[8]**

Q7) a) Explain the concept of domains in ferromagnetic materials. **[4]**

b) What is antiferromagnetism? Define Neel temperature. **[4]**

c) Distinguish between metals, insulators and semiconductors on the basis of band theory. **[8]**

Total No. of Questions : 7]

SEAT No. :

P2095

[Total No. of Pages : 2

[4822]-41
M.Sc.
PHYSICS
PHY UTN - 801 : Nuclear Physics
(2008 Pattern) (Semester - IV)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Q. 1 is compulsory, attempt any Four from the remaining.***
2) ***Draw neat figures wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculator is allowed.***

Q1) Attempt any four of the following: **[16]**

a) Compute the maximum energy of compton recoil electrons resulting from the absorption in Al of 2.19 MeV γ-rays.

b) What are ortho & para hydrogen? Show that $\frac{\sigma_{ortho}}{\sigma_{para}} = 2$.

c) In a certain betatron the maximum magnetic field was 4000 guass operating at 50 cycles per sec with a stable orbit of 60 inches. Calculate the average energy gained per revolution. Also calculate final energy of electrons.

d) Which of the following reactions are allowed or forbidden under conservation of strangeness, Baryon number and charge.

i) $\pi^+ + n \rightarrow \wedge^o + K^+$

ii) $\pi^+ + n \rightarrow K^o + K^+$

e) Calculate the total cross-section of n-p scattering of neutrons having energy 2 MeV. Given a_t = 5.38 F a_s = –23.7F, r_{ot} = 1.7F, r_{os} = 2.4F.

f) Find the energy released if two ${}^2_1H$ nuclei can fuse to form ${}^2_4$He nucleus. Given B.E. per nucleon of ${}^2_1H$ and ${}^4_2$He is 1.1 MeV and 7.00 MeV respectively.
Given M_n = 1.008665 V and M_P = 1.00727640V.

P.T.O.

Q2) a) What do you mean by Solid state detector? Explain principle and working of surface barrier detector. **[8]**

b) Explain the Magnetic dipole moment. Show that for the nucleus of mass number A the magnetic dipole moment. **[8]**

$$\bar{\mu} = \frac{\mu_0 e}{2m}\left[\sum_{k=1}^{A} g_s \bar{S}_k + \sum_{k=1}^{Z} g_l \bar{l}_k\right].$$

Q3) a) Describe the Gamow's theory of α-decay. Hence deduce Geiger-Nutal Law. **[8]**

b) What are elementary particles? Give in details the classification of elementary particles. **[8]**

Q4) a) Write a note on nuclear reactors in India. **[8]**

b) What is straggling? Obtain an expression for straggling when a charged particle is moving through matter. **[8]**

Q5) a) Outline briefly the phase-shift analysis in n-p scattering. Hence derive an expression for **[8]**

i) scattering cross-section

ii) scattering Amplitude

b) Describe the construction and working of Van-de-Graff accelerator. **[8]**

Q6) a) Explain in brief electron synchrotron and proton synchrotron. **[8]**

b) What are the basic components of nuclear reactor. Discuss with a special reference to Graphite Moderated reactor. **[8]**

Q7) a) For elementary particles explain the concept of strangeness. **[4]**

b) Define scattering length. Write an expression for it and interpret. **[4]**

c) State the assumptions of Fermi theory of β decay. **[4]**

d) What is electric quardruple moment? **[4]**