

Total No. of Questions : 7]

SEAT No. :

P1034

[Total No. of Pages : 2

[5429]-11

M.Sc. (Physics) (Semester - I)

PHY UTN:501 CLASSICAL MECHANICS

(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) Question No. 1 is compulsory and solve any four questions from remaining.
- 2) Neat diagrams must be drawn wherever necessary.
- 3) Figures to the right indicates full marks.
- 4) Use of calculator is allowed.

Q1) Attempt any four of the following:

- a) Write down the lagrangian for a simple pendulum and obtain its equation of motion. Also find the period of oscillations. [4]
- b) Prove that the distribution law. $[F, G+K] = [F, G] + [F, K]$ for poissons brackets holds good. [4]
- c) Write equation of constraint for a particle moving on or outside surface of sphere. [4]
- d) A particle of mass 'm' describes an elliptical orbit about a centre of attractive force at one of its foci given by $-k/r^2$. Show that the speed of the particle at any point of the orbit is given by $v^2 = \frac{k}{m} \left(\frac{2}{r} - \frac{1}{a} \right)$ where 'a' is the semi - major axis. [4]
- e) Prove that the generating function $F = \sum q_i p_i$ generates identity transformation. [4]
- f) Describe the Hamiltonian and Hamilton's equation for an ideal spring mass system. [4]

Q2) a) Explain the brachistocrone problem. [8]

- b) For What values of α and β do the equations $Q = q^\alpha \cos \beta p$, $P = q^\alpha \sin \beta p$ represent a canonical transformation? [8]

P.T.O.

- Q3)** a) A particle describes circular orbit given by $r = 2a \cos \theta$ under the influence of an attractive force directed towards a point on the circle, show that the force varies as the inverse of fifth power of distance. [8]
- b) Evaluate the poisson's brackets. [8]
- i) $[L_y, y]$
- ii) $[L_x, P_x]$
- Q4)** a) A cylinder of radius R and mass M rolls down an inclined plane making an angle α with horizon. Set up the lagrangian and find the equation of motion. [8]
- b) Use variational principle of prove that shortest distance between two points in a plane is straight line. [4]
- c) Deduce the equation of motion for Atwood's machine by applying principle of virtual work. [4]
- Q5)** a) Show that for relativistic free particle, Hamiltonian is expressed as $H = \sqrt{p^2 c^2 + m_0^2 c^4} + V(r)$. [8]
- b) Write lagrangian and Lagrange's equation of motion compound pendulum. [8]
- Q6)** a) What is Foucault's pendulum? Obtain an equation of motion for such a pendulum. [8]
- b) Find equation of motion of pendulum bob suspended by a spring allowed to swing in vertical plane. [8]
- Q7)** a) What do you mean by pseudo force? Obtain an expression for coriolis acceleration for rotating coordinate system. [8]
- b) For certain canonical transformation it is known that
- $$Q = \sqrt{q^2 + p^2}, F = \frac{1}{2}(q^2 + p^2) \tan^{-1} \frac{q}{p} + \frac{1}{2}qp \text{ find } P(q,p) \text{ and } F(q,Q). \quad [8]$$



Total No. of Questions : 7]

SEAT No. :

P1035

[Total No. of Pages : 2

[5429]-12

M.Sc. Physics (Semester - I)
PHY UTN:502 ELECTRONICS
(2008 Pattern)

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 circuit diagrams wherever necessary.*
- 3) *Figures to the right indicate full marks.*
- 4) *Use of logarithmic table and calculator is allowed.*

Q1) Attempt any four of the following:

- a) Define CMRR and slew rate of OPAMP. How its affects performance of OPAMP? [4]
- b) Design 1st order Low pass filter with $f_h = 5$ KHZ and pass band gain of 2. [4]
- c) Draw practical circuit of sample - Hold amplifier. Explain its working. [4]
- d) Design astable multivibrator using IC 555 to produce output waveform with frequency of 10 KHZ and duty cycle of 60%. [4]
- e) Draw internal block diagram of 3-pin voltage regulator. Explain function of each block. [4]
- f) Draw circuit diagram of monostable multivibrator using OPAMP. Explain its working. [4]

Q2) a) Draw internal block diagram of IC 8038. Derive expression for its output frequency. Explain its working. [8]

- b) What is DC-DC converter? Explain its operation. States its types and two applications. [8]

Q3) a) Draw circuit diagram of 2-OPAMP function generator. Explain its working. Derive formula for its output frequency. How can you control its characteristics? [8]

- b) Design 2-bit simultaneous ADC. Prepare its truth table and explain its operation. State its merits and demerits. [8]

P.T.O.

- Q4)** a) Draw circuit diagram of 4 bit- synchronous, UP-DOWN counter. Explain its operation. [8]
 b) How can you use PLL IC 565 for, [8]
 i) Multiplying the input frequency by 5.
 ii) Shifting the input frequency by 5 KHZ.
- Q5)** a) Draw internal block diagram of IC 723. Explain function of each block. How this IC can be used to generate 5 volt output at 100 mA maximum load current? [8]
 b) Design a logic circuit that generates an even parity bit for a 4-bit binary number input. [4]
 c) Explain the concept of successive approximation type ADC. [4]
- Q6)** a) Define following terms: [8]
 i) Acquisition and aperture time of sample -hold amplifier.
 ii) Lock and capture range of PLL.
 iii) Characteristics of ADC.
 iv) Load and Line regulation of voltage regulator.
 b) Design 16:1 multiplexer using 4:1 multiplexers. [4]
 c) Design regulated power supply using IC LM 317 to produce variable output voltage of 5 V to 15 V. [4]
- Q7)** Write short notes on any four of the following. [16]
 a) Dual slope ADC.
 b) Optical fiber communication.
 c) PLA
 d) VCO IC 566
 e) Instrumentation amplifier.
 f) Decade counter IC 7490.



[5429]-13

M.Sc.(Semester - I)

PHYSICS

**PHY UTN - 503 : Mathematical Methods in Physics
(2008 Pattern)**

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 diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table and calculator is allowed.

Q1) Attempt any four of the following:

- a) Let $V = \mathbb{R}^3$. Determine whether W is a subspace of V where:
 $W = \{(a,b,c); a+b+c = 0\}$ [4]
- b) Discuss whether or not $\mathbb{R}^2$ is a subspace of $\mathbb{R}^4$. [4]
- c) Prove that if $L\{f(t)\} = F(s)$ then $L\{e^{at} f(t)\} = F(s-a)$. [4]
- d) Evaluate:

$$\oint_C \frac{\cos z}{(z-\pi)} dz$$
where C is the circle $|z-1|=3$. [4]
- e) Prove that:
 $H_{n+1}(x) = 2x H_n(x) - 2n H_{n-1}(x)$ [4]
- f) Prove that: [4]

$$J_{n+1}(x) = \frac{2n}{x} J_n(x) - J_{n-1}(x)$$

- Q2)** a) State and prove the orthogonality property of Hermite functions. [8]
- b) Find the dimension of the vector space spanned by: [8]
- i) $(1, -2, 3, -1)$ and $(1, 1, -2, 3)$
 - ii) $t^3 - 2t^2 + 5$ and $t^2 + 3t - 4$

- Q3)** a) Determine the first three Legendre polynomials $P_0(x)$, $P_1(x)$ and $P_2(x)$. [8]
- b) State and prove Laurent's theorem. [8]

P.T.O.

- Q4)** a) Obtain the associated Legendre functions. $P_2^1(x)$, $P_3^2(x)$ and $P_2^3(x)$. [8]
 b) Find Laurent series about the indicated singularity for each of the following functions. Name the singularity in each case and give the region of convergence of each series. [8]

i) $\frac{e^z}{(z-1)^2}; z=1$

ii) $Z \cos \frac{1}{z}; Z=0$

Q5) a) Find $L^{-1} \left\{ \frac{5s^2 - 15s + 7}{(s+1)(s-2)^3} \right\}$. [8]

- b) Diagonalize the following matrix: [8]

$$A = \begin{pmatrix} 2 & -2 \\ -2 & 5 \end{pmatrix}$$

- Q6)** a) Prove that: [8]

i) $L\{\cos \omega t\} = \frac{s}{s^2 + \omega^2}$

ii) $L\{\sin \omega t\} = \frac{\omega}{s^2 + \omega^2}$

- b) Determine whether or not the following vectors in R^3 are linearly dependent; [8]

i) $(2, -3, 7), (0, 0, 0), (3, -1, -4)$

ii) $(1, 1, 1), (1, 0, 0), (0, 1, 0), (0, 0, 1)$

- Q7)** a) What are odd and even functions? Write Fourier coefficients for odd and even functions. [4]

- b) Normalize each of the following vectors in Euclidean space R^3 ; [4]

i) $u = (2, 1, -1)$ ii) $v = \left(\frac{1}{2}, \frac{2}{3}, \frac{-1}{4}\right)$

- c) State and prove Cauchy Riemann equations for a function to be analytic. [4]

- d) Prove that: [4]

If $L\{f(t)\} = F(s)$

then $L\{f(at)\} = \frac{1}{a} F\left(\frac{s}{a}\right)$



[5429]-14

M.Sc. (Physics) (Semester - I)

PHYUTN-504: QUANTUM MECHANICS- I
(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) Question No. 1 is compulsory solve any four questions from the remaining.
- 2) Draw neat diagrams wherever necessary.
- 3) Figures to the right indicates full marks.
- 4) Use of logarithmic table and electronic pocket calculator is allowed.

Q1) Attempt any four of the following:

[16]

- a) Write a note on probability interpretation of ψ . Write orthonormality condition and discuss it.
- b) Wave function of a particle moving in free space is given by, $\psi = e^{ikx} + 2e^{-ikx}$. Find the energy of the particle.
- c) The matrix of an operator M in orthonormal basis $\{|1\rangle, |2\rangle\}$ is written as

$$\begin{pmatrix} 2 & i\sqrt{2} \\ -i\sqrt{2} & 3 \end{pmatrix}.$$

- i) Is M is Hermitian?
- ii) What are its eigen values?
- iii) Express corresponding normalized eigenvectors, in terms of $\{|1\rangle, |2\rangle\}$.
- d) Write a note on addition of angular momenta.
- e) Discuss physical significance of eigen values and eigen functions.
- f) The operators for angular momenta are:

$$J_+ = J_x + iJ_y \text{ and } J_- = J_x - iJ_y. \text{ Show that}$$

$$\text{i) } [J_+, J_-] = 2\hbar J_z \text{ and ii) } [J_z, J_-] = -\hbar J_-$$

P.T.O.

- Q2)** a) What are Hermitian operators? Show that eigenvalues of Hermitian operator are real and eigenfunctions corresponding to distinct eigenvalues are orthogonal. [8]
- b) For Non-Hermitian operators J_+ and J_- , show that. [8]
- $$J_{\pm}|j, m\rangle = \sqrt{j(j+1) - m(m\pm 1)} \hbar |j, m\pm 1\rangle$$
- Q3)** a) In the Heisenberg picture, solve the Heisenberg equation of motion for x and p for a Harmonic oscillator. [8]
- b) A particle is described by $\psi(x) = \left(\frac{\pi}{\alpha}\right)^{-\frac{1}{4}} e^{-\alpha x^2/2}$. Calculate Δx and Δp . Verify uncertainty principle. [8]
- Q4)** a) Draw potential well for finite values of potential energy. Write Schrodinger equations in both cases. Draw first two eigenfunctions for both and discuss the differences in two cases. [8]
- b) Consider a two-dimensional physical system. The kets $|\psi_1\rangle$ and $|\psi_2\rangle$ form an orthogonal basis of the state space. Let $|\phi_1\rangle$ and $|\phi_2\rangle$ be new basis given by $|\phi_1\rangle = \frac{1}{\sqrt{2}}(|\psi_1\rangle + |\psi_2\rangle)$ and $|\phi_2\rangle = \frac{1}{\sqrt{2}}(|\psi_1\rangle - |\psi_2\rangle)$. An operator $\hat{A}$ is represented in the $|\psi_i\rangle$ basis by the matrix $(A_{ij})_{\psi_i} = \begin{pmatrix} 1 & \varepsilon \\ \varepsilon & 1 \end{pmatrix}$. Find the representation of $\hat{A}$ in the basis $|\phi_i\rangle$ i.e. find matrix $(A_{ij})_{\phi_i} = \langle \phi_i | \hat{A} | \phi_j \rangle$. [8]
- Q5)** a) Using the abstract operator method, obtain the eigen value spectrum of H for one dimensional harmonic oscillator. [8]
- b) Obtain Clebsch-Gordon coefficients by adding the angular momenta of two non-interacting electrons with $j_1 = 1/2$ and $j_2 = 1/2$ [8]
- Q6)** a) What are Dirac's bra and ket vectors. With respect to these vectors, define Hilbert space. [8]
- b) Compare the Schrodinger picture and Heisenberg picture of time evolution. Hence, show that $i\hbar \frac{d}{dt} A_H(t) = [A_H, H_H] + i\hbar \left(\frac{\partial A}{\partial t} \right)_H$ in Heisenberg picture. [8]

- Q7)** a) Normalize the wavefunction $\psi(x) = A \sin\left(\frac{n\pi x}{a}\right)$, $-a < x < a$, for a particle moving in a one dimensional potential well of width a . [4]
- b) State postulates of quantum mechanics. [4]
- c) Let $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Show that α and β are eigenvectors of Pauli spin matrix σ_z . [4]
- d) Compare Dirac δ and Kronecker δ functions. Represent Dirac δ function graphically. [4]



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[5429]-21

M.Sc. (Semester - II)

PHYSICS

PHYUTN - 601 : Electrodynamics

(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) Question No. 1 is compulsory & solve any four questions from the remaining.
- 2) Draw neat labelled diagrams wherever necessary.
- 3) Figures to the right 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 $\left(\frac{U_e}{U_m}\right)$ is equal to unity. [4]
- b) Find the phase velocity of a plane wave at a frequency 10 GHz in polyethelene material
Given $\mu_0 = \mu = 4\pi \times 10^{-7} \text{ N/A}$ [4]
 $\epsilon_r = 2.3$
 $\sigma = 2.56 \times 10^{-4} \text{ mho/m}$
 $\epsilon_0 = 8.85 \times 10^{-12} \frac{\text{coulomb}^2}{\text{N} - \text{m}^2}$
- c) Explain the term 'Four vector potential'. [4]
- d) Write Maxwell's equation in differential & integral form. [4]
- e) Show that another point form of Faradays law is $\vec{E} = -\frac{\partial \vec{A}}{\partial t}$
Where $\vec{A}$ is magnetic potential. [4]
- f) An electron is moving at a speed of $1.8 \times 10^8 \text{ m/s}$. Find the ratio of its effective mass to its rest mass. [4]

P.T.O.

- Q2)** a) If a medium is moving with velocity $\vec{u}$, then show that the Faraday's law has the form $\vec{\nabla} \times (\vec{E} - \vec{u} \times \vec{B}) = \frac{-\partial \vec{B}}{\partial t}$ [8]
- b) What is linear quadrupole? Derive an expression for potential at a distant point due to a small linear quadrupole. [8]
- Q3)** a) Derive the Lorentz relativistic transformation equations. [8]
- b) Using the concept of e.m. energy, show that the power transferred to the e.m. field through the motion of charge in volume v is given by [8]
- $$-\int (\vec{j} \cdot \vec{E}) dv = \frac{d}{dt} \int_v \frac{1}{2} (\vec{E} \cdot \vec{D} + \vec{B} \cdot \vec{H}) dv + \int_{C.S.} (\vec{E} \times \vec{H}) \cdot d\vec{s}$$
- Q4)** a) State & prove Poynting's theorem. [8]
- b) Show that $C^2 B^2 - E^2$ & $\vec{E} \cdot \vec{B}$ are invariant under Lorentz transformation. [8]
- Q5)** a) What is Hertz potential? Show that the electric & magnetic field can be expressed in terms of Hertz potential as [8]
- $$\vec{E} = \vec{\nabla} \times (\vec{\nabla} \times \vec{Z}) \text{ \& } \vec{B} = \frac{1}{C^2} \frac{\partial}{\partial t} (\vec{\nabla} \times \vec{Z}) \text{ where } \vec{Z} \text{ is Hertz potential.}$$
- b) Describe the Michelson-Morley experiment & discuss the results obtained by it. [8]
- Q6)** a) Explain the term 'Electromagnetic field Tensor'. Hence, obtain an expression for e.m. field tensor $F_{\mu\nu}$. [8]
- b) Show that Maxwell's equation in a charge free region is expressed by [8]
- $$\nabla^2 \vec{E} - \frac{K\mu}{C^2} \frac{\partial^2 \vec{E}}{\partial t^2} - \mu \frac{\partial \vec{E}}{\partial t} = 0.$$
- Explain which term can be ignored in a non-conducting medium. [8]
- Q7)** Write notes on any two 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) Minkowski force.
- d) Magnetic interaction between two current loops.



[5429]-22

M.Sc. (Semester - II)

PHYSICS

PHYUTN - 602 : Atoms, Molecules and Solids

(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) Question No. 1 is compulsory, solve any five 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 pocket calculator is allowed.

Given:

Rest mass of electron	= 9.109×10^{-31} kg.
Charge on electron	= 1.6021×10^{-19} Coulomb
Plank's constant	= 6.626×10^{-34} Js
Boltzman constant	= 1.38054×10^{-23} Jk ⁻¹ .
Avogadro's number	= 6.02252×10^{26} (k-mole) ⁻¹
Bohr magneton	= 9.27×10^{-24} amp-m ²
1eV	= 1.6021×10^{-19} J

Q1) Attempt any four of the following:

- a) Show that the maximum radius of the sphere that can just fit into the void at the body centre of the fcc structure confined by the facial atoms is $0.414r$. Where r is the radius of the atom. [4]
- b) Determine Lande's of factor for $^2P_{3/2}$. [4]
- c) The value for lower and upper states of C_2 are 0.0071 and 0.00919 respectively. Find the number of levels in upper and lower states. [4]
- d) The Zeeman components of 500 nm spectral line are 0.0106 nm apart when the magnetic field is 0.4 T. Find e/m . [4]
- e) What would be the effect on specific heat of solids at room temperature if Plank's constant h is increased 10 folds. [4]
- f) Calculate the magnetic field required to get a transition frequency 60 MHz for fluorine:

Given $g_N = 5.255$, $\mu_N = 5.051 \times 10^{-27}$ JT⁻¹ [4]

P.T.O.

- Q2)** a) Derive an expression for specific heat of a solid based on Einstein model. What are the drawbacks of this model. [8]
 b) Explain the theory of geometrical structure factor and derive expression for fcc lattice. [8]
- Q3)** a) Derive the expression for concentration of vacancies in Frankel defect. [8]
 b) Explain briefly the information one can get from the vibrational analysis of an electronic vibration spectra. [8]
- Q4)** a) State and explain Fanck-Codon Principle. [8]
 b) Explain the principle of NMR. Explain working of a typical NMR spectrometer and write the applications of it. [8]
- Q5)** 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 vibrational coarse structure explaining ν' progradation. Explain with the help of necessary diagrams. [8]
- Q6)** a) Discuss the vibrational modes of one- dimensional monoatomic lattice of identical atoms hence obtain the dispersion relation. Represent graphically. [8]
 b) In the context of rotational fine structure of electronic vibration spectra explain band origin and band head. [8]
- Q7)** a) Write note on edge dislocations. [4]
 b) What are Normal and Umklapp processes. [4]
 c) Obtain an expression for configurational entropy. [4]
 d) Explain concept of phonon and quantization of elastic waves. [4]



[5429]-23

M.Sc.

PHYSICS (Semester - II)

PHYUTN-603: Statistical Mechanics in Physics
(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

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

Constants:

- 1) Boltzmann's constant, $K_B = 1.38 \times 10^{-23} \text{ Joule/}^\circ\text{K}$
- 2) Plank's constant, $h = 6.625 \times 10^{-34} \text{ Joule.Sec.}$
- 3) Avogadro's number $N = 6.023 \times 10^{23} \text{ mole}^{-1}$
- 4) Mass of electron, $m_e = 9.1 \times 10^{-31} \text{ kg.}$
- 5) Velocity of light, $C = 3 \times 10^8 \text{ m/s}$

Q1) Attempt any four of the following:

- a) Distinguish between microstate and macrostate. [4]
- b) Explain the concept of phase space. [4]
- c) Show that the entropy in canonical ensemble can be represented as

$$S = -k \sum P_r \ln P_r$$
and show that this entropy is additive. [4]
- d) A particle of unit mass is executing simple harmonic vibrations. Determine its trajectory in phase space. [4]
- e) The energy parameters and accessible states for two systems A and B are given below: [4]

System A

System B

$$E_1 = 3, 4, 5$$

$$E_2 = 3, 4, 5$$

$$\Omega_1 = 10, 30, 90$$

$$\Omega_2 = 20, 50, 120$$

If the systems are in thermal contact with each other, obtain the maximum number of accessible state for 8 units of energy in the equilibrium.

P.T.O.

- Q2) a)** For a system in contact with the heat reservoir (canonical ensemble) show that probability of finding the system in a particular microstate r of

energy E_r is given by: $P_r = \frac{e^{-\beta E_r}}{\sum_r e^{-\beta E_r}}$ [8]

- b) Show that for classical monoatomic ideal gas having N particles contained in volume V , the number of State $\Omega(E)$ to the system in the energy range E and $E+dE$ is given by
 $\Omega(E) = BV^N E^{3N/2}$ [8]

- Q3) a)** State the partition function for F.D. statistics and obtain the Fermi-Dirac distribution in the form.

$\bar{n}_s = \frac{1}{e^{\beta(\epsilon_s - \mu)} + 1}$ where μ is chemical potential. [8]

- b) On the basis of canonical distribution, obtain Curies Law of paramagnetism. [8]

- Q4) a)** Obtain partition function of a photon gas. Hence derive plank's radiation formula. [8]

- b) What is Gibbs paradox? How is it resolved? [8]

- Q5) a)** Show that Maxwell distribution of speed is given by [8]

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

- b) State and prove Liouville's theorem. [8]

- Q6) a)** Show that the fluctuation in the number of particles in the system in grand canonical ensemble is given by [8]

$\bar{N}^2 - \bar{N}^2 = KT \left(\frac{\partial \bar{N}}{\partial \mu} \right)_{V,T}$

- b) Show that the relation $PV = \frac{2}{3} E$ is satisfied by a gas of free monatomic particles in quantum statistics (B.E. and F.D. statistics) [8]

- Q7) a)** Show that the Fermi energy of fermions is

$\epsilon_F = \frac{\hbar^2}{2m} \left(\frac{3\pi^2 N}{v} \right)^{\frac{2}{3}}$ [8]

- b) On the basis of canonical distribution, obtain the law of atmosphere,
 $P_z = P_0 e^{-mgz/kT}$ [8]



Total No. of Questions : 7]

SEAT No. :

P1041

[Total No. of Pages : 2

[5429]-24

M.Sc. (Physics) (Semester - II)

PHYUTN-604: QUANTUM MECHANICS-II
(2008 Pattern)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

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

Q1) Attempt any four of the following:

- a) Explain Identical particles in quantum mechanics. What is difference between bosons and fermions? [4]
- b) State the conditions for validity of Born approximation in scattering. [4]
- c) Define exchange operator $\hat{P}$. Show that $[\hat{H}, \hat{P}] = 0$, where $\hat{H}$ is Hamiltonian operator. [4]
- d) The harmonic oscillator is perturbed by $H' = bx^4$. Obtain first order perturbation in energy in the ground state. [4]
- e) Explain the concept of harmonic perturbation. [4]
- f) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$, obtain the ground state of harmonic oscillator by variational method. [4]

- Q2)** a) Discuss the time-independent perturbation theory for non-degenerate states. Obtain first order corrections to the energy. [8]
- b) Using WKB method, obtain expression for transmission probability for slowly varying potential barrier. [8]

- Q3)** a) Obtain an expression for Fermi-Golden rule. [8]
- b) Obtain the relation between scattering crosssections in Lab and CM frame. [8]

P.T.O.

- Q4)** a) What do you mean by partial wave? Obtain the phase shift δ_l for scattering from the square well potential. [8]
 b) Explain the stark effect in first excited state of the hydrogen atom. [8]
- Q5)** a) Using WKB approximation, explain the concept of field emission of electrons. [8]
 b) Construct symmetric and anti-symmetric wave functions for two-electron system. [8]
- Q6)** a) Using Born approximation, obtain scattering cross-section for yukawa potential. [8]
 b) Discuss classical and quantum mechanical pictures of collisions between identical particles. [8]
- Q7)** a) Discuss the selection rules for electric dipole transitions. [4]
 b) Show that total energy in scattering is related as $T_{cm} = \frac{m_2}{m_1 + m_2} T_{lab}$. [4]
 c) Explain Zeeman effect using perturbation. [4]
 d) State conditions of validity of WKB approximation. [4]



[5429]-31
M.Sc.
PHYSICS
PHYUTN-701:Solid State Physics
(2008 Pattern)

*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) *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:**Planck's constant = 6.626×10^{-34} JS.**Mass of electron = 9.1×10^{-31} Kg.**Boltzmann constant = 1.38×10^{-23} J/k.**Avogadro's Number = 6.0225×10^{26} /kilomole.**Bohr Magneton = 9.27×10^{-24} A-m²**Charge of electron = 1.6×10^{-19} C.**Permeability of free space = $4\pi \times 10^{-7}$ Henry/m.**Permittivity of free space = 8.85×10^{-12} C²/Nm².***Q1)** Attempt any four of the following:**[16]**

- a) A copper wire of length 0.5 metre and dia meter 0.3 mm has a resistance of 0.12Ω at 20°C . If the thermal conductivity of copper at 20°C is $390 \text{ Wm}^{-1} \text{ K}^{-1}$, calculate Lorentz number.
- b) For an electron with Fermi energy show that the wavelength is given by

$$\lambda_f = 2 \left[\frac{\pi}{3n} \right]^{1/3}$$

- c) The relaxation time of conduction electron in copper is 2.5×10^{-14} sec. Find the thermal conductivity of copper at 0°C . Assume the density of electrons to be $8.5 \times 10^{28}/\text{m}^3$.
- d) Consider He atom in its ground state. Its mean radius is $0.53 \text{ \AA}$. Density of He is 0.178 kg/m^3 and atomic weight is 4 amu, calculate the diamagnetic susceptibility of He atom.

P.T.O.

- e) The London penetration depths for Pb at 3°K and 7.1 °K are respectively 39.6 nm and 173 nm. Calculate the depth at 0°K.
- f) The relative permittivity of Argon at 0°C and one atmosphere is 1.000435. Calculate the polarizability of the atom.
- Q2)** a) Distinguish between reduced zone, extended zone and periodic zone scheme of representing energy bands. [8]
- b) What is ferroelectric effect? Describe the spontaneous polarization in Barium titanate. [8]
- Q3)** a) Draw neat diagram showing construction of 2D Fermi surfaces in first, second and third Brillouin zones. Explain these diagrams. [8]
- b) State and prove Bloch theorem. [8]
- Q4)** a) Explain the paramagnetic phenomenon. Derive an expression for paramagnetic susceptibility using Langevin theory of paramagnetism. [8]
- b) Explain the hysteresis curve on the basis of domain theory. [8]
- Q5)** a) Derive the London equation for the superconducting state and obtain the expression for penetration depth. [8]
- b) Derive an expression for local electric field for an atom at general lattice site. [8]
- Q6)** a) Distinguish between Ferromagnetism, antiferromagnetism and ferrimagnetism. [8]
- b) i) What is cyclotron resonance. [4]
- ii) Explain Meissner effect in superconductors. [4]
- Q7)** a) What are the assumptions of BCS theory of superconductors. [8]
- b) i) The atomic radius of Sodium is 1.86 °A. Calculate the Fermi energy of Sodium at 0°K. [4]
- ii) Describe the term 'Bloch wall' with reference to magnetism. [4]



[5429]-41
M.Sc.PHYSICS
PHYUTN-801: Nuclear Physics
(2008 Pattern) (Semester - IV)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) Question No. 1 is compulsory and attempt any four questions from the remaining.
- 2) Draw the neat diagrams wherever necessary.
- 3) Figures to the right indicates full marks.
- 4) Use of logarithmic tables and pocket calculator is allowed.

Q1) Attempt any four of the following:

- a) Which of the following reactions are allowed or forbidden under the conservation of strangeness, conservation of Baryon number and conservation of charge. [4]
 - i) $\pi^+ + n \rightarrow K_0 + \Sigma^+$
 - ii) $\pi^+ + n \rightarrow \Lambda^0 + K^+$
 - iii) $\pi^+ + n \rightarrow K^0 + K^+$
 - iv) $\pi^+ + n \rightarrow \pi^- + p$
- b) In a certain betatron the maximum magnetic field was 4000 gauss operating at 50 cycles per sec with a suitable orbit of 60 inches. Calculate the average energy gained per revolution. Also calculate final energy of electrons. [4]
- c) Compute maximum energy of compton recoil electrons resulting from the absorption in Al to 2.19 MeV γ -rays [4]
 (Given: $M_0 = 9.109 \times 10^{-31}$ kg)
- d) Calculate the half value thickness for β absorption in Aluminum for β spectrum with $E_{\max} = 1.17$ MeV. Density of Al = 2.7 gm/cm³. [4]
- e) Find the energy released if two ${}^2_1\text{H}$ nuclei can fuse to form ${}^4_2\text{He}$ nucleus. Given : B.E. per nucleon of ${}^2_1\text{H}$ and ${}^4_2\text{He}$ is 1.1 MeV and 7.00 MeV respectively. [4]
 ($M_n = 1.008665$ u and $M_p = 1.00727640$ u)

P.T.O.

- f) For energy filters in mass-spectrometers, show that $\frac{1}{2}mV^2 = \frac{neVR_0}{2d}$, where symbols have their usual meanings. [4]
- Q2)** a) Write a note on nuclear reactor in India. [8]
 b) Discuss for interactions among the elementary particles. [8]
- Q3)** a) For P-P scattering at low energies, derive an expression for differential cross section in laboratory system. [8]
 b) Explain important features of Gamow's theory of α -decay. Hence deduce Geiger-Nutal law. [8]
- Q4)** a) State assumptions of Fermi theory of β -decay. Find the probability of emission of e per unit time. [8]
 b) What are elementary particles? Give in details the classification of elementary particles. [8]
- Q5)** a) Describe the construction and working of Van-de Graff accelerator. [8]
 b) Define and explain the term: Effective range. [4]
 c) What is electrical quadruple moment? [4]
- Q6)** a) With the help of partial wave analysis for low energy n-p scattering. Show that $\sigma_0 = \frac{4\pi}{k^2} \sin^2 f_0$, where symbols have their usual meanings. [8]
 b) Explain the concept of Isospin associated with elementary particle. [4]
 c) Evaluate the maximum energy shift that can be observed for a body whose quadruple moment Q. [4]
- Q7)** a) Explain in concept of nuclear magnetic moment and show that $\mu = \mu_s + \mu_l$.

$$= \frac{\mu_0 l}{2m} [g_s S + g_l l]$$
 [8]
 b) Discuss the theory of microtron. Show that the increase in energy after each orbit is given by.

$$\Delta E = \frac{E_0 V}{\mu - V}, \text{ where symbols have their usual meanings.}$$
 [8]

