Total No. of Questions : 7]

SEAT No. :

P1811

[Total No. of Pages : 3

[5322]-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) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of Calculator and logarithmic table is allowed.***

Q1) Attempt any four of the following:

a) Two heavy particles of weights W_1 and W_2 connected by a light in extensible string and hang over a fixed smooth circular cylinder of radius R, the axis of which is horizontal. Find the condition of equilibrium of the system by applying the principle of virtual work. **[4]**

b) The Lagrangian of a problem is $L=\frac{1}{2}m\left(\dot{r}^2+ r^2\ \dot{\theta}^2 \right)+ V(r)$. Identify the cyclic coordinate and the corresponding conservation law for the problem. **[4]**

c) Explain the terms-configuration space, phasespace and state space and draw phase space diagrams for one dimensional oscillator. **[4]**

d) A particle sliding down on an inclined plane under the influence of gravity. Specify the types of constraints. **[4]**

e) Prove that generating function $F = \Sigma q_i p_i$ generates identify transformation

f) Use variation principle to prove that shortest distance between two points in a plane is straight line. **[4]**

P.T.O.

Q2) a) Find equation of motion of pendulum bobsuspended by a spring allowed to swing in a vertical plane. **[8]**

b) Find the canonical transformations defined by the generating function

$$F(q,Q) = qQ - \frac{1}{2}\, mwq^2 - \frac{Q^2}{4mw}.$$ **[8]**

Q3) a) What do you mean by pseudo force? Obtain an expression for Coriolis acceleration for rotating coordinate system. **[8]**

b) Write down the Lagrangian for a particle of mass 'm' in a conservative force field in cylindrical polar coordinates. **[8]**

Q4) a) Find the equation to the curve passing through two fixed points such that the area of the surface obtained by revolving the curve about y-axis is minimum. **[8]**

b) Explain with example, sceleronomous and rheonomous constraints. **[4]**

c) Explain Geosynchronous orbit and Geostationary orbit. **[4]**

Q5) a) Find Hamilton's equation of motion in polar cylindrical coordinates. **[8]**

b) The transformation equations between two sets of coordinates are $P = 2\left(1+\sqrt{q}\cdot\cos p\right)\sqrt{q}\cdot\sin p$ and $Q = \log\left(1+\sqrt{q}\cdot\cos p\right)$. Show that

i) The transformation is canonical and

ii) The generating function of this transformation is $F_3 = -\left(e^Q - 1\right)^2 \tan p$.

[8]

Q6) a) A bullet is fired horizontally in a north direction with a velocity of 500 m/s at 30°N lattitude. Calculate the horizontal component of coriolis acceleration and the consequent deflection of the bullet as it hits a target 250 m away. Also determine the vertical displacement of bullet due to gravity. If the mass of bullet is 10 gm, find the coriolis force. **[8]**

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

Q7) a) Using Euler-Lagrange differential equation, prove that if *f* does not depend on '*x*' explicitly then $f - y' \frac{\partial f}{\partial y'} =$ constant. **[8]**

b) Find the canonical transformations defined by the generating function $F_3 = -\frac{1}{2} Q^2 \tan 2p$. **[8]**

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Total No. of Questions : 7]

SEAT No. :

P1812

[Total No. of Pages : 2

[5322]-12

M.Sc.

PHYSICS

PHYUTN 502 : Electronics

(2008 Pattern) (Semester - I)

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 side indicate full marks.***
4) ***Use of logarithmic tables and calculators is allowed.***

Q1) Attempt any four of the following.

a) State and define any four parameters of OPAMP with its ideal and real values. **[4]**

b) Draw circuit diagram of active low pass first order filter. Derive expression for its transfer function. **[4]**

c) Draw internal block diagram of IC 723. Explain function of each block. **[4]**

d) Design 4:1 multiplexer and implement it using NAND gates only. **[4]**

e) Write comparative note on R-2R and binary weighted type DAC. **[4]**

f) Draw circuit diagram of sample - hold amplifier. Explain its working. State the requirements of its components. **[4]**

Q2) a) Draw circuit diagram of 3.OPAMP instrumentation amplifier. Derive expression for its output voltage. State its four characteristics and applications. **[8]**

b) What is SMPS? Draw its circuit diagram and explain its working. What are its advantages over other voltage regulators. **[8]**

P.T.O.

Q3) a) Draw internal block diagram of IC 7490. Explain its operation. How it can be used as MOD - 7 Counter with and without using additional logic gate? **[8]**

b) What is precision rectifier? Draw circuits of half wave and full wave precison rectifier. Explain its operation. **[8]**

Q4) a) Draw block diagram of VCO IC 506. Explain its operation. Prove that its output frequency depends upon control voltage. **[8]**

b) What is PLL? Draw block diagram of IC 565. Explain its working. Determine its free running frequency, lock range and capture range if $R_T = 10K\Omega$, $C_T = 0.1\ \mu F$, $C_F = 1\mu F$, and $V_{CC} = \pm 10V$. **[8]**

Q5) a) Draw internal block diagram of IC 7495. How it can be used as shift left and shift right register? State its four applications. **[8]**

b) Draw circurit diagram of dual slope ADC. Prove that its time interval for second integration depends upon input analog voltage. Explain its working. State its advantages over single slope ADC. **[8]**

Q6) a) Determine the resolution of 4-bit R-2R DAC if Logic 0 = 0v and logic 1 = 16v. Also determine its analog output if digital inputs are

i) 0101

ii) 1010 **[4]**

b) Design Butterworth high pass second order filter for $f_l = 1KHz$. **[4]**

c) Draw ciruit diagram of astable multivibrator using OPAMP. Explain its working and derive expression for its output frequency. How can you change its duty cycle? **[8]**

Q7) Write short note on any four of the following. **[16]**

a) UPS

b) Two applications of PLL

c) Successive approximation ADC.

d) Simultaneous ADC

e) Karanaugh - Map

f) Satellite communication

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Total No. of Questions : 7]

SEAT No : ____

P 1813

[Total No. of Pages :3

[5322]-13

M.Sc. : PHYSICS

PHYUTN 503 : MATHEMATICAL METHODS IN PHYSICS

(2008 Pattern) (Semester - I) (Credit System)

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 diagram whenever 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) Discuss whether or not R^2 is a subspace of R^3. **[4]**

b) Define Basis and dimension of a vector space. Is dimension of a particular vector space unique? Explain. **[4]**

c) Prove that if $L\{f(t)\}=F(s)$ then $L\{e^{at}f(t)\}=F(s-a)$. **[4]**

d) Determine the residue of $\frac{z\,e^{zt}}{(z-3)^2}$ at $z = 3$. **[4]**

e) Obtain the first two Hermite's Polynomials. **[4]**

f) Prove that : $H_n'(x) = 2n\,H_{n-1}(x)$ **[4]**

Q2) a) Let V be the vector space of polynomials with inner product given by

$$< f,g >= \int_0^1 f(t)\,g(t)\,dt$$ **[8]**

Let $f(t) = t+2$ and $g(t) = t^2-2t-3$.

Find $<f,g>$ and $||f||$.

P.T.O.

b) State and prove the orthogonality property of Hermite functions. **[8]**

Q3) a) Obtain the associated Legendre functions **[8]**

$$P_2^1(x),\ P_3^2(x) \text{ and } P_2^3(x)$$

b) State and prove Laurent's theorem **[8]**

Q4) a) Determine the first three Legendre polynomials $P_0(x)$ $P_1(x)$ and $P_2(x)$. **[8]**

b) State Residue theorem. Explain how the Cauchy's theorem and integral formulas are special cases of Residue theorem **[8]**

Q5) a) Find eigenvalues and eigen vectors of matrix **[8]**

$$A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$$

b) Find $L^{-1}\left\{\dfrac{5s^2 - 15s + 7}{(s+1)(s-2)^3}\right\}$ **[8]**

Q6) a) Determine whether or not the following vectors in R^3 are linearly dependent :

i) (1,0,0), (0,0,0), (0,0,1)

ii) (1,2,3), (2,4,5), (1,0,0), (0,0,1) **[8]**

b) Find the Fourier transform of : **[8]**

$f(x) = 1 \quad |x| < a$

$f(x) = 0 \quad |x| > a$

Q7) a) Normalize each of the following vectors in Euclidean space R^3.

i) $u = (1, 1, 1)$ ii) $v = (2, 1, -1)$ **[4]**

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

c) Find Laplace transform of *Cosh(at).* **[4]**

d) What is half way Fourier sine and half way Fourier cosine series? **[4]**

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Total No. of Questions :7]

SEAT No. :

P1814

[Total No. of Pages :3

[5322] - 14

M.Sc.

PHYSICS

PHYUTN - 504 : Quantum Mechanics - I

(2008 Pattern) (Semester - I) (Credit System)

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

Instructions to the candidates:

1) ***Question 1 is compulsory; Attempt four from the remaining.***
2) ***Draw neat diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators allowed.***

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

a) Using Dirac rotations, prove that eigen values of Hermition operator are real.

b) If $\bar{\psi} = \sum_a Ca\psi a,$ where ψ_a is eigen function of operator A with eigen value 'a' and Ca is constant, then show that $< A >= \sum_a |Ca|^2 .a.$

c) The ground state eigen function for harmonic oscillator is

$$\psi(x) = \left(\frac{\alpha}{\sqrt{\pi}}\right)^{1/2} e^{-\alpha^2 x^2/2}$$

obtain uncertainty in position $\Delta x.$

d) Show that pauli spin matrices σ_x, σ_y, and σ_z are unitary.

e) Show that a and a^+ operators of harmonic oscillator satisfy $[a, a^+] = 1.$

f) Show that momentum operator is Hermitian.

P.T.O.

Q2) a) Using Schrödinger's equation obtain eigen values and eigen functions for linear harmonic oscillator. **[8]**

b) Obtain L_x and L_y matrices for $l = 1$ **[8]**

Q3) a) Obtain Clebsch - Gordon coefficients for a system of two non - interacting particles with angular momenta $j_1 = ½$ and $j_2 = ½$. **[8]**

b) Explain unitary transformations. If U is a unitary operator and if $<\psi|\psi> = 1$ then show that $<U\psi|U\psi> = 1$. **[8]**

Q4) a) Explain the adjoint of an operator. If A is adjoint operator, show that $(A + B)^+ = A^+ + B^+$ and $(AB)^+ = B^+A^+$. **[8]**

b) Obtain the eigen value spectrum of $\hat{L}^2$ and $\hat{L}_z$ operator. **[8]**

Q5) a) Let S be the spin angular momentum operator on two states $\alpha = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ and $\beta = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, obtain Pauli spin matrices σ_x, σ_y and σ_z. **[8]**

b) Consider a linear operator $\hat{F}$ such that $F|\psi> = |x>$, where $|\psi>$ and $|X>$ are arbitrary vectors. Represent $\hat{F}$ as a matrix element in A representation. **[8]**

Q6) a) Using Ladder operators a and a^+, show that for harmonic oscillator, $H = \left(aa^+ - \frac{1}{2}\right)\hbar w.$ and $E = \left(n + \frac{1}{2}\right)\hbar w.$ **[8]**

b) What is meant by simulteneous eigen functions. Show that $[A, B^n] = n[A, B]\, B^{n-1}$. **[8]**

Q7) a) State physical significance of eigen values and eigen functions of an observable. **[4]**

b) Obtain J_y matrix for j = ½. **[4]**

c) Obtain <*x*> for $\psi n\,(x) = \sqrt{2/a}\,\sin\left(\frac{n\pi}{a}x\right)$ from $x = 0$ to a for infinite square well potential. **[4]**

d) State postulates of quantum mechanics. **[4]**

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Total No. of Questions : 7]

SEAT No : ____

P 1815

[Total No. of Pages :2

[5322]-21
M.Sc.
PHYSICS
PHY UTN - 601 : Electrodynamics
(2008 Pattern) (Semester-II) (Old Course)

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 diagram 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) Calculate the magnitude of poynting vector at the surface of the sum. **[4]**

Given: i) The power radiated by the sun = 3.8×10^{26} Watt.

ii) Radius of the sun = 7×10^{8} m.

b) Find the rest mass of an electron in eV if its rest mass is 9.11×10^{-31} kg. **[4]**

c) State Faraday's law of e.m. induction. Write its mathematical form. **[4]**

d) Two identical bodies move towards each other the speed of each being 0.9 C. Find their speed relative to each other. **[4]**

e) Prove that $\vec{E}.\frac{\overrightarrow{\partial D}}{\partial t} = \frac{\partial}{\partial t}\left(\frac{1}{2}\vec{E}.\vec{D}\right)$ & $\vec{H}.\frac{\overrightarrow{\partial B}}{\partial t} = \frac{\partial}{\partial t}\left(\frac{1}{2}\vec{H}.\vec{B}\right)$. **[4]**

f) Write the expression for Lorentz's & Coulomb's gauges. Hence explain the two conditions. **[4]**

Q2) a) If $\vec{C} = \vec{\nabla}\times\vec{Z}$, then show that $C_{\phi} = \frac{P_1}{4\pi \in R}\sin\left(\frac{1}{R}ik\right)e^{ikR}$. **[8]**

b) Explain the term 'multipole moments'. Derive an expression for potential at a distant point using multipole expansion for a localized charge distribution in free space. **[8]**

P.T.O.

Q3) a) What is e.m. tensor? Obtain an expression for the e.m. field tensor given by.

$$F_{\mu\nu} = \begin{vmatrix} F_{11} & F_{12} & F_{13} & F_{14} \\ F_{21} & F_{22} & F_{23} & F_{24} \\ F_{31} & F_{32} & F_{33} & F_{34} \\ F_{41} & F_{42} & F_{43} & F_{44} \end{vmatrix}$$ **[8]**

b) Show that Maxwell's equation in a charge free region is expressed by $\nabla^2\vec{E} - \frac{kkm}{e^2}\frac{\partial^2\vec{E}}{\partial t^2} - \mu 6\frac{\partial\vec{E}}{\partial t} = 0$. Explain which term can be ignored in a non - Conducting medium. **[8]**

Q4) a) Prove that the space time interval $x^2 + y^2 + z^2$ is not invaciant under Larentz transformation, while the combined space time interval $x^2 + y^2 + z^2 - c^2t^2$ is Larentz invariant. **[8]**

b) Prove the relativistic addition theorem for velacities. **[8]**

Q5) a) Starting from Maxwell's equation, derive inhomogeneous wave equation in terms of scalar potential (ϕ) & vector potential $\left(\vec{A}\right)$. **[8]**

b) Define Hertz Dipole vector. Using potential for dipole, obtain radiation dipole field which is given by $E_\theta = \frac{\sin\theta\, e^{ikR}}{4\pi \in_0 R}\left[\left(\in \overline{P_1} \times \overline{K}\right) \times K\right]$. **[8]**

Q6) a) State & prove poyntings theorem. **[8]**

b) Describe Larentz force on a charged particle. **[8]**

Q7) a) Obtain an expression for Fresnel's equation if the electric field vectors are perpendicular to the plane of incidence. **[8]**

b) Show that the square of four wave vector k_μ is zero. **[8]**

Total No. of Questions :7]

SEAT No. :

P1816

[Total No. of Pages : 2

[5322]-22
M.Sc.
PHYSICS
PHYUTN - 602 : Atoms, Molecules and Solids
(2008 Pattern) (Semester - II)

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

Instructions to the candidates:

1) ***Questions No.1 is compulsory, solve any five questions of 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.***

Given :

Rest mass of electron	$= 9.109 \times 10^{-31}$kg
Charge on electron	$= 1.6021 \times 10^{-19}$ coulomb
Plank's constant	$= 6.626 \times 10^{-34}$ Js
Boltzman constant	$= 1.3805n \times 10^{-23}$ Jk^{-1}
Avogatro's number	$= 6.02252 \times 10^{26}$ $(k. mole)^{-1}$.
Bohr magneton	$= 9.27 \times 10^{-24}$amp-m^2
1eV	$= 1.6021 \times 10^{-19}$ J

Q1) Attempt any **four** of the following :

a) The ground state of chlorine is $^2P_{3/2}$. Find the magnetic moment of chlorine. **[4]**

b) The highest possible lattice frequency is $11.85 \times 10^{12} 5^{-1}$ in case of silicon. Estimate the Debye temperature for silicon. **[4]**

c) 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]**

d) The Zeeman components of a 650nm spectral line are 0.014nm apart, when magnetic field is 1.25 Tesla. Find the ratio e/m for the electron.**[4]**

e) The diffusion coefficient of copper atom in A^1 is found to be 1.28×10^{-22} m^2 s^{-1} at 400 k and 5.75×10^{-19} $m^2 5^{-1}$ at 500 k. Find the temperature at which its value is $10^{-16} m^2 s^{-1}$. **[4]**

f) The value of x_e for lower and upper states of C_2 are 0.0071 & 0.00919 respectively. Find the number of levels in upper and lower states. **[4]**

P.T.O.

Q2) a) Discuss Laue's theory of x-ray diffraction. Hence obtain the condition for diffraction maxima. **[8]**

b) Derive an expression for the specifics heat of a solid based on Einstein model. What are the drawbacks of this model? **[8]**

Q3) a) Derive an expression for the temperature dependance of the concentration of schottkey defects in an ionic crystal. **[8]**

b) Derive the dispersion relation for a linear diatomic lattice and explain origin of optical and acoustic mode. **[8]**

Q4) a) Write note on vibrational coarse structure explaining v' progration. Explain with the help of necessary diagrams. **[8]**

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

Q5) a) Explain band origin and band head in relation to rotational fine structure of electronic vibrational and spectra. **[8]**

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

i) Screw dislocation and

ii) Edge dislocation

Q6) a) Define atomic scattering factor and show that its maximum value is equal to the atomic number Z of the atom. **[8]**

b) Explain the principle of NMR. Explain the working of typical NMR spectrometer and write the application of it. **[8]**

Q7) a) Explain concept of phonon and quantization of elastic waves. **[4]**

b) What are the Normal and Umklapp processes? **[4]**

c) What are the factors responsible for broadening of the spectral line? **[4]**

d) Describe an experiment to dekect defects in the solid. **[4]**

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Total No. of Questions : 7]

SEAT No : ____

P 1817

[Total No. of Pages :3

[5322]-23
M.Sc.
PHYSICS
PHY UTN - 603 : Statistical Mechanics in Physics
(2008 Pattern) (Semester-II) (Old 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 calculators is allowed.***

Constants:-

1) Boltzmann's constant k_B = 1.38×10^{-23} Joule/°k.
2) Planck's constant h = 6.625×10^{-34} Joule sec.
3) Avogadro's number N = 6.023×10^{23} $mole^{-1}$.
4) Mass of electron m_e = 9.1×10^{-31} kg.
5) Velocity of light C = 3×10^{8} m/s.

Q1) Attempt any four of the following:

a) "To a given macrostate of the system there correspond a large number of microstates". Comment. **[4]**

b) Calculate the mean value $\bar{E}$ for canonical ensemble in terms of partition function . **[4]**

c) Explain, what do you mean by thermal interaction. **[4]**

d) State and explain the postulate of equal-a-priority probability. **[4]**

e) A system of three 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 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 **[8]**

$$P_r = \frac{e^{-\beta E_r}}{\Sigma r e^{-\beta E_r}}.$$

b) Discuss the phenomenon of sharpness of probability distribution in statistical thermo dynamics and show that the final width of maximum in P(E) is given by **[8]**

$$\frac{\Delta^* E}{\bar{E}} = \frac{1}{\sqrt{f}}$$

Q3) a) Show that the mean energy of the fermions at absolute zero is **[8]**

$$\varepsilon_0 = \frac{3}{5} \in_f$$

b) Write a note on white dwarf. **[8]**

Q4) a) State the partition function for M-B statistics and show that the quantum distribution function for M-B distribution is **[8]**

$$\bar{n}_s = \frac{N e^{-\beta \in_s}}{\Sigma_s e^{-\beta \in_s}}$$

b) Show that the for temperature smaller than the Debye temperature $(T << \theta_D)$ the specific heat of solid is given by **[8]**

$$C_V = \frac{12}{5} \pi^4 N k \left(\frac{T}{\theta_D} \right)^2$$

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

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

b) Discuss Bose-Einstein condensation of bosons. **[8]**

Q6) a) Show that energy fluctuation in canonical distribution is given by **[8]**

$$\overline{(\Delta \mathrm{E})^2} = k\,\mathrm{T}^2\,\mathrm{C_V}$$

Where $\mathrm{C_V}$ is the heat capacity at constant volume.

b) On the basis of canonical distribution, obtain tha law of atmosphere $p(z) = p(0)e^{-mgz/k\mathrm{T}}$ **[8]**

Q7) a) Obtain an expression for vibrational specific heat of constant volume for a diatomic volume. **[8]**

b) State and prove Liouville's theorem in classical statistics. **[8]**

Total No. of Questions :7]

SEAT No. :

P1818

[Total No. of Pages : 2

[5322] - 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 1 is compulsory. Attempt any four from the followings.***
2) ***Figures to the right indicate full marks.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Use of log-tables and calculators allowed.***

Q1) Attempt any four of the followings :

a) What are the limitations of Born approximation? **[4]**

b) Show that the total scattering cross-section is $\sigma = \frac{4\pi}{k} \mathrm{I_m}\, f(0)$ where $f(0)$ is the forward scattering amplitude. **[4]**

c) Show that there is no stark effect in the ground state of hydrogen atom. **[4]**

d) Discuss the concept of symmetry in quantum mechanics. **[4]**

e) Explain the principle of variational method. Show that variational method gives upper bound to ground state energy. **[4]**

f) Using perturbation theory explain Zeeman effect for a hydrogen atom. **[4]**

Q2) a) Obtain the total scattering cross-section for scattering from rigid sphere. Consider both low and high energy limits. **[8]**

b) State and prove Fermi-Golden rule for transition to continuum. **[8]**

Q3) a) Using WKB approximation obtain energy of the harmonic potential $V(x) = \frac{1}{2} m w^2 x^2$. **[8]**

b) Develop the time dependent perturbation theory to obtain first order correction to the amplitude $a_m^{(1)}(t)$. **[8]**

P.T.O.

Q4) a) The harmonic oscillator is perturbed by $H^1 = bx^4$. Obtain first order perturbation in energy in the n^{th} state. **[8]**

b) Explain symmetric and antisymmetric wave functions. Obtain slater determinant for system of N electrons. **[8]**

Q5) a) Using time independent perturbation theory show that first order correction to the energy is given as $E_n^1 = < n \left| H^1 \right| n >$. **[8]**

b) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$ obtain ground state energy of harmonic oscillator by variational method. (α is variational parameter). **[8]**

Q6) a) Using WKB approximation, explain field emission of electrons. **[8]**

b) Deduce the expression for scattering amplitude using Born approximation for square well potential. **[8]**

Q7) a) Explain collision of two indentical particles. **[4]**

b) Write the connection formulae in WKB approximation across the turning points with positive and negative slopes. **[4]**

c) Explain Einstein coefficients for spontaneous emission. **[4]**

d) Using WKB approximation, obtain Bohr-Sommer-feld quantization condition. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P1819

[Total No. of Pages : 3

[5322]-31
M.Sc.
PHYSICS
PHY UTN - 701 : Solid State Physics
(2008 Pattern) (Semester - III)

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 diagram wherever necessary.***
4) ***Use of Logarithmic table and pocket calculator is allowed.***

Given:

Planck's constant = 6.626×10^{-34} J-s

Mass of electron = 9.1×10^{-31} kg

Boltzmann constant = 1.38×10^{-23} J/k

Avogadro's number = 6.023×10^{23}/mole

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

Charge of electron = 1.6×10^{-19}C

Permittivity of free space = 8.85×10^{-12} C^2/N^-m^2

Bohr Magneton = 9.27×10^{-24} Am^2.

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

a) Calculate the energy of an electron below the Fermi level at a temperature 200K for f (E) = 0.9 and Fermi energy E_F = 3 eV.

b) A magnetic material has a magnetization of 3300 A/m and flux density of 0.0044 Wb/m^2. Calculate the magnetizing force and the relative permeability of the material.

P.T.O.

c) The London penetration depths for pb at 3k and 7.1K are 39.6 nm and 173 nm respectively calculate the depth at zero degree kelvin.

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

e) A material having a dielectric constant 5 is positioned in region between the parallel plates. Compute the polarizibility.

f) The relative permittivity of Argon at 0°C and one atmosphere is 1.000435. Calculate the polarizability of the atom.

Q2) a) Starting with the electron drift velocity expression derive the relation between conductivity at frequency w, σ (w) and σ (0). **[8]**

b) Distinguished between reduced zone, extended zone and periodic zone scheme of representing energy bands. **[8]**

Q3) a) Explain the paramagnetic phenomenon. Derive an expression for paramagnetic susceptibility using Longevin theory of paramagnetism. **[8]**

b) For an atom placed at general lattice site, derive an expression for local electric field E_{local}. **[8]**

Q4) a) Explain the hysteresis curve on the basis of domain theory. **[8]**

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

Q5) a) Explain the classification of metals, semiconductors and insulators based on band theory. **[8]**

b) Explain Antiferromagnetism with reference to Neel temperature and susceptibility. Hence describe ferrimagnetism. **[8]**

Q6) a) Explain the following terms with diagrams. **[8]**

i) Exchange energy ii) Anisotropy energy

b) i) State and explain Bloch theorem. **[4]**

ii) Explain cyclotron resonance. **[4]**

Q7) a) i) Explain Meissner effect in super conductivity. **[4]**

ii) Explain Josephson effect in superconductors. **[4]**

b) i) The atomic radius of sodium is 1.86 $\mathring{A}$. Calculate the fermi energy of sodium at 0°K. **[4]**

ii) Explain the term 'Bloch wall' with reference to magnetism. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P1820

[Total No. of Pages : 2

[5322]-41
M.Sc. (Physics)
PHY UTN - 801 : NUCLEAR PHYSICS
(2008 Pattern) (Semester - IV)

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

Instructions to the candidates:

1) ***Question No. 1 is compulsory.***
2) ***Attempt any four from the remaining.***
3) ***Draw neat diagram wherever necessary.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

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

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

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

i) $\pi^+ + n \rightarrow k^o + \Sigma^+$

ii) $\pi^- + p \rightarrow \pi^o + \gamma^o$

c) Compute maximum energy of compton recoil electrons resulting from the absorption in Al of 2.19 MeV γ-rays (Given : $m_0 = 9.109 \times 10^{-31}$ kg)

d) Calculate the half value thickness for β absorption in aluminium for β spectrum with $E_{max} = 1.17$ MeV. Density of Aluminium = 2.7 gm/cm^3.

e) Determine the scattering length a_t and a_s where $\sigma_{para} = 4.19$ barns and $\sigma_{ortho} = 128$ barns.

f) Calculate the range of 9 MeV particles in Aluminina if the relative stopping power is 1700. Also calculate the thickness of Aluminium that is equivalent in stopping power to 1 meter air (Given $\rho_{Al} = 2700$ kg/m^3)

P.T.O.

Q2) a) Describe the construction and working of Bainbridge and Jordon mass spectrometer. **[8]**

b) Explain in brief electron synchrotron & proton synchrotron. **[8]**

Q3) a) What are the basic components of nuclear detector? Discuss with a special reference to graphite moderated Reactor. **[8]**

b) Describe the Gamow's theory of α decay. Hence deduce Geiger-Natal law. **[8]**

Q4) a) Describe the electron scattering method to measure the radius of the nucleus. **[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) Show that for low energy n-p scattering $\delta_0 = \frac{4\pi}{k^2}\sin^2\delta_0$, where symbols have their usual meaings. **[8]**

b) Explain the concept of isospin associated with the elementary particles. **[4]**

c) Evaluate the maximum energy shift that can be observed for a body whose quadruple moment Q. **[4]**

Q7) a) Derive Bethe's formula for 'stopping power' of charged particles moving through matter. Write expression for relativistic effect. **[8]**

b) Discuss the theory of microtron. Show that the increase in energy after each orbit is given by $\Delta E = \frac{E_0 V}{\mu - V}$, where symbols have their usual meanings. **[8]**

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