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 $\vartheta^2 = \frac{k}{m}\left(\frac{2}{r} - \frac{1}{a}\right)$ 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 brachirstocrone 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 $H = \sqrt{p^2c^2 + m_0^2c^4} + V(r)$. **[8]**

b) Write lagrangian and Lagrange's equation of motion compound pendulum. **[8]**

Q6) a) What is Focault'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 verticle 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

$Q = \sqrt{q^2 + p^2}, F = \frac{1}{2}(q^2 + p^2)\tan^{-1}\frac{q}{p} + \frac{1}{2}qp$ find P(q,p) and F(q,Q). **[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.

Total No. of Questions : 7]

SEAT No. :

P1036

[Total No. of Pages : 2

[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 $V = R^3$. Determine whether W is a subspace of V where:
$W = \{(a,b,c);\ a+b+c = 0\}$ **[4]**

b) Discuss whether or not R^2 is a subspace of 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) $\dfrac{e^z}{(z-1)^2}; z=1$

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

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

b) Diagonalize the following matrix: **[8]**

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

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

i) $L\{\cos\omega t\}=\dfrac{S}{S^2+\omega^2}$

ii) $L\{\sin\omega t\}=\dfrac{\omega}{S^2+\omega^2}$

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) $v=\left(\dfrac{1}{2},\dfrac{2}{3},\dfrac{-1}{4}\right)$

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 $L\{f(at)\}=\dfrac{1}{a}F\left(\dfrac{S}{a}\right)$

Total No. of Questions : 7]

SEAT No. :

P1037

[Total No. of Pages : 3

[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, $\psi = e^{ikx}+2\,e^{-ikx}$. 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:

$J_+=J_x+iJ_y$ and $J_-=J_x-iJ_y$. Show that

i) $[J_+,J_-]= 2\,\hbar J_z$ 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]**

$$J\pm|j,m\rangle=\sqrt{j(j+1)-m(m\pm1)}\,\hbar\,|j,m\pm1\rangle$$

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 $(Aij)_{\psi_i}=\begin{pmatrix}1 & \varepsilon\\ \varepsilon & 1\end{pmatrix}$. Find the representation of $\hat{A}$ in the basis $|\phi_i\rangle$ i.e. find matrix $(Aij)_{\psi_i}=\langle\phi_i|\hat{A}|\phi_j\rangle$. **[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=½ and j_2=½ **[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 Kroneker δ functions. Represent Dirac δ function graphically. **[4]**

Total No. of Questions : 7]

SEAT No. :

P1038

[Total No. of Pages : 2

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

ϵ_r = 2-3

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

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{coulomb^2}{N - m^2}$$

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 1.8×10^8 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 $\vec{\nabla}\times\left(\vec{E}-\vec{u}\times\vec{B}\right)=\frac{-\partial\vec{B}}{\partial t}$ **[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 $C^2B^2-E^2$ & $\vec{E}\cdot\vec{B}$ 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

$\vec{E}=\vec{\nabla}\times(\vec{\nabla}\times\vec{Z})$ & $\vec{B}=\frac{1}{C^2}\frac{\partial}{\partial t}(\vec{\nabla}\times\vec{Z})$ where $\vec{Z}$ is Hertz potential. **[8]**

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

$$\nabla^2\vec{E}-\frac{KKm}{C^2}\frac{\partial^2\vec{E}}{\partial t^2}-\mu\sigma\frac{\partial\vec{E}}{\partial t}=0.$$

Explain which term can be ignored in a non-conducting medium. **[8]**

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

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

b) Law of relativistic addition of velocities.

c) Minkowsky force.

d) Magnetic interaction between two current loops.

Total No. of Questions : 7]

SEAT No. :

P1039

[Total No. of Pages : 2

[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	$= 9.109 \times 10^{-31}$ *kg.*
Charge on electron	$= 1.6021 \times 10^{-19}$ *Coulomb*
Plank's constant	$= 6.626 \times 10^{-34}$ *Js*
Boltzman constant	$= 1.38054 \times 10^{-23} Jk^{-1}$.
Avogadro's number	$= 6.02252 \times 10^{26} (k\text{-}mole)^{-1}$
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) 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 υ' progration. 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]**

Total No. of Questions : 7]

SEAT No. :

P1040

[Total No. of Pages : 2

[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,* $K_B = 1.38\times10^{-23}$ *Joule/°K*
2) *Plank's constant,* $h = 6.625\times10^{-34}$ *Joule.Sec.*
3) *Avogadro's number* $N = 6.023\times10^{23}$ *mole*$^{-1}$
4) *Mass of electron,* $m_e = 9.1\times10^{-31}$*kg.*
5) *Velocity of light,* $C = 3\times10^{8}$ *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 Ω(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.

$\bar{n}_s = \frac{1}{e^{\beta}(\in_s - \mu)_{+1}}$ 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 drive 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]**

$$F_{(\nu)}d\nu = 4\pi n\left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}} \nu^2 \frac{-m\nu^2}{2kT} d\nu$$

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

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

b) On the basis of canonical distribution, obtain the law of atmosphere,
$P_{(z)} = P(o)\ e^{-mgz/kT}$ **[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 $\left[\hat{H},\hat{P}\right]=0$, 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 crossections 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]**

Total No. of Questions : 7] **SEAT No. :**

P1042 **[Total No. of Pages : 2**

[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–m^2
Charge of electron = 1.6×10^{-19} C.
Permeability of free space = $4\pi\times10^{-7}$ Henry/m.
Permittivity of free space = 8.85×10^{-12} C^2/Nm^2.

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 0.12 Ω at 20°C. If the thermal conductivity of copper at 20°C is 390 $Wm^{-1} K^{-1}$, 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 $8.5\times10^{28}/m^3$.

d) Consider He atom in its ground state. Its mean radius is 0.53Å. 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 Brillowin 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]**

Total No. of Questions : 7]

SEAT No. : ____

P1043

[Total No. of Pages : 2

[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) $\pi^+ + n \rightarrow K_\circ + \sum^+$

ii) $\pi^+ + n \rightarrow \wedge^\circ + K^+$

iii) $\pi^+ + n \rightarrow K^\circ + K^+$

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 A1 to 2.19 MeV γ -rays **[4]**

(Given: $M_o = 9.109 \times 10^{31}$ kg)

d) Calculate the half value thickness for β absorption in Aluminum for β spectrum with E_{max} = 1.17 MeV. Density of A1= 2.7 gm/cm^3. **[4]**

e) Find the energy released if two ^2_1H nuclei can fuse to form ^4_2He nucleus.

Given : B.E. per nucleon of ^2_1H and ^4_2He is 1.1 MeV and 7.00 MeV respectively.

(M_n=1.008665V and M_p=1.00727640V) **[4]**

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 $\mu = \mu_s + \mu_l$.

$$= \frac{\mu_o l}{2m}[g_s.S + g_l.l]$$ **[8]**

b) Discuss the theory of microtron. Show that the increase in energy after each orbit is given by. **[8]**

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