Total No. of Questions :7]

SEAT No. :

P2643

[Total No. of Pages :2

[5022]-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 any four from the remaining.***
2) ***Draw neat diagram wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of log. table & calculator is allowed.***

Q1) Attempt any four of the following:

a) Obtain the cangrangian& equation of motion for a one dimensional harmonic oscillator **[4]**

b) Show that the generating function F_3=PQ leads to an identity transformation **[4]**

c) Calculate the reduced mass of co & H_2 molecule. **[4]**

d) Solve the Atwood's machine problem by using D Alembert principle **[4]**

e) Prove that **[4]**

i) [qi, pj]= δ ij,

ii) [qi,qj] = 0

f) Calculate the period of rotation of the plane of oscillation of Foucault's pendulum at **[4]**

i) Polc

ii) equator

Q2) a) Check the canonicality of following transformation **[8]**

$$Q = \sqrt{2q}\, e^{t} \cos p, \quad P = \sqrt{2q}\, e^{-t} \sin p$$

b) Explain the concept scleronomic & rhconomic constraint with examples. **[4]**

c) Explain the concept of virtual displacement & obtain the principle of virtual work **[4]**

P.T.O.

Q3) a) Show that

i) [u+v,w] = [u,w]+ [v,w]

ii) [cu,dv] = cd[u,v], where c&d are constants **[8]**

b) Obtain the Hanitonian for a charged particle moving through electromagnectic field. **[8]**

Q4) a) Solve the projectile motion problem by Langrage's equation of motion **[8]**

b) Show that the geodesics of sphere is a great circle **[8]**

Q5) a) State and prove virial theorem **[8]**

b) Starting from Newton's law obtain kepler's 1st &2nd law. **[8]**

Q6) a) If langrangian of the system is $L = \frac{1}{2}\mu\left(\dot{r}^2 + r^2\dot{q}^2\right) + \frac{GMm}{r}$, Find the constant of Motion. Also obtain corresponding Hamiltonian of the system **[8]**

b) State & prove poisson's second theorem **[8]**

Q7) a) Reduced a two body central force problem to on equivalent one body problem **[8]**

b) Explain the difference between phase space& configuration space. **[4]**

c) Explain the effect of coriolis force on air flow on the surface of the earth. **[4]**

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Total No. of Questions :7]

SEAT No. :

P2644

[Total No. of Pages :2

[5022]-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 solve any four question of the remaining.*
2) *Draw neat diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table & pocket calculators is allowed.*

Q1) Attempt any four of the following:

a) Derive an expression for gain of noninverting amplifier using OPAMP. state its advantages over inverting amplifier. **[4]**

b) Design a second order Butterworth low pass filter using OPAMP for a cutoff frequency of 5KHz. **[4]**

c) State necessary requirements of a instrumentation amplifier. **[4]**

d) Draw a block diagram of counterramp type ADC. Explain its operation. **[4]**

e) Design a variable frequency oscillator using VCO IC 566 for fo= 10KHz-30KHz. (Given Vcc= 12 volt) **[4]**

f) Design regulated voltage power supply using IC 723 to produce output voltage of 5V and output current of 65mA **[4]**

Q2) a) Draw a circuit diagram of astable multivibrator using OPAMP. Explain its operation. Design it to produce output frequency of 10KHz. How it can be modified to obtain same frequency with 80% duty cycle. **[8]**

b) Draw internal block diagram of IC 7495. Explain its operation with reference to timing waveforms How it can be used as shift-left and shift-right register? **[8]**

Q3) a) Draw a block diagram of 4.bit parallel binary UP/DOWN Counter. Explain its operation with reference to timing diagrams. **[4]**

b) What is SMPS? Draw its block diagram and explain its operation **[4]**

c) Draw internal block diagram of PLL IC 565. Explain its working. Determine its free running frequency. Lock range and capture range if $R_T = 10K\Omega$, $C_T = 0.01\mu$ F, $C_F = 10\mu$ F and Vcc= $\pm 6V$. **[8]**

Q4) a) Draw internal block diagram of IC 7490. Explain its working How it can be used as. **[8]**

i) MOD 6 counter

ii) MOD 7 counter using Rg1 and Rg2

iii) MOD 7 counter without using Rg1 and Rg2

b) Draw circuit diagram of full-wave precision rectifier. Explain its operation. What will be smallest amplitude of the signal that this circuit can rectify if it uses silicon diode and OPAMP IC 741. What will be the output frequency if input frequency is 500 Hz? **[8]**

Q5) a) Draw a circuit diagram of 2.bit flash ADC. Explain its operation. State its merits and demerits. **[8]**

b) Draw a circuit diagram of a sample-hold amplifier circuit. State and explain its characteristics. State basic requirements of a capacitor. switch and amplifier. **[8]**

Q6) a) Draw internal block diagram of IC 555. Explain its operation as astable multivibrator. Design it to produce 10 KHz frequency with 60% duty cycle. **[8]**

b) Draw internal block diagram of IC 8038. Explain its working. **[4]**

c) Design a logic circuit to implement following logic expression. **[4]**

$$Y = \sum m\,(0, 1, 2, 4, 5, 6)$$

Q7) a) What is PLA? Explain its design with suitable example **[4]**

b) Draw internal block diagram of 3 -pin regulator. Explain function of each block. State its advantages over precision regulator. **[4]**

c) Write a short note on DC-DC converter. **[4]**

d) Explain in brief the process of satellite communication. **[4]**

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Total No. of Questions :7]

SEAT No. :

P2645

[Total No. of Pages :3

[5022]-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. 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 tables and calculator is allowed.*

Q1) Attempt any four of the following:

a) Find Laplace transform of cosh(at). **[4]**

b) Let V be the set of ordered pairs of real numbers: V= {(a,b): a,b∈ R}. Show that V is not a vector space over R with respect to the following operation of addition in V and scalar multiplication on V:

(a,b)+(c,d)=(a+c,b+d)

and k(a,b)=(ka,b) **[4]**

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

d) Prove: $|z_1 + z_2| \le |z_1| + |z_2|$. **[4]**

e) Prove the following for Legendre polynomials=

$P_n(-x) = (-1)^n P_n(x)$ **[4]**

f) Determine the residue of $\dfrac{ze^{zt}}{(z-3)^2}$ at z=3. **[4]**

P.T.O.

Q2) a) State and prove Cauchy-Schwarz inequality. **[8]**

b) Obtain the fourier series corresponding to the function: **[8]**

$f(x)=0, \quad -5<x<0$

$f(x)=3, \quad 0<x<5$ period=10

Q3) a) Find $\alpha^{-1}\left\{\frac{3s+1}{(s-1)(s^2+1)}\right\}$ **[8]**

b) Let $A=\begin{pmatrix}1 & 2\\ 3 & 4\end{pmatrix}$ and let T be the linear operator on R^2 defined by $T(V)=AV$

(where V is written as a column vector).

Find the matrix of T in each of the following bases:

i) $\{e_1=(1,0),\ e_2=(0,1)\}$, i.e. usual basis,

ii) $\{f_1=(1,3),\ f_2=(2,5)\}$ **[8]**

Q4) a) State and prove the orthogonality property of Legendre polynomials. **[8]**

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

Q5) a) Using the Rodrigue's formula for Hermite's polynomials obtain the first three Hermite polynomials $H_0(x)$, $H_1(x)$ and $H_2(x)$. **[8]**

b) State and prove Cauchy Riemann equations for a function to be analytic. **[8]**

Q6) a) Diagonalize the following matrix: **[8]**

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

b) Find the Fourier transform of:

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

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

Also, graph $f(x)$ and its fourier transfrom for $a = 3$ **[8]**

Q7) a) Prove that: **[4]**

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

b) Evaluate $\oint_C \frac{\cos z}{(z-\pi)} dz$ where C is the circle $|z-1| = 3$. **[4]**

c) Prove that:

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

d) Prove Taylor's theorem. **[4]**

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Total No. of Questions :7]

SEAT No. :

P2646

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[5022]-14

M.Sc.

PHYSICS

PHY UTN- 504:Quantum Mechanics-I

(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 & electronic pocket calculator is allowed.***

Q1) Attempt any four of the following:

a) Determine whether or not the function $f(x) = Ae^{-x^2/2}$ is an eigenfunction of the operator $\left(\frac{d^2}{dx^2} - x^2\right)$ if it is, what is its eigenvalue? **[4]**

b) Estimate the ground state enegy of linear harmonic oscillator using uncertainty relation. **[4]**

c) Explain projection operator . Why it is called unit operator. **[4]**

d) Prove that the operator $L_+ = L_x + iL_y$ is a raising angular momentum operator. **[4]**

e) Using Dirac notation prove that eigen values of Hermitian operator are real. **[4]**

f) Show that the angular momentum operator is the generator of the rotational motion. **[4]**

Q2) a) Obtain matrices representing the operators **[10]**

$\hat{J}^2, \hat{J}_\pm, \hat{J}_n, \hat{J}_y$ *and* $\hat{J}_z$ for j=1/2

b) When a set of functions $\{\psi_a\}$ will be orthonormal and complete? Hence, obtain the closure relation $\sum_a \psi_a(x)\psi_a^x(x) = \delta(x - x')$. **[6]**

P.T.O.

Q3) a) What is spin angular momentum? For spin:½ the spin angular momentum operator, operating on states $\alpha = \begin{pmatrix} 1 \\ 0 \end{pmatrix} and \beta = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$. Obtain the matrix representation for S_x,S_y and S_z. Hence define Pouli spin matrices. **[8]**

b) Obtain equation of motion for a linear operator $A_H(t)$ in the Heisenberg picture. Discuss its similarities with Hamiltonian equation in classical mechanics. **[8]**

Q4) a) Obtain the eigen values of L^2 and L_z operators. **[8]**

b) Explain the terms: **[8]**

i) State vectors and Dirac notations

ii) Norm and Scalar product.

iii) Hilbert space and basis in it for any arbitrary $|\psi\rangle$

Q5) a) The square -well potential for a finite well is defined as: **[8]**

$V(x) = V_o$ for x<-a and x>a

$= 0$ for $-a < x < a$

For a particle having $E<V_o$; discuss the bound states.

b) State and explain four postulates of quantum mechanics. **[8]**

Q6) a) A linear operator $\hat{F}$ takes a vector $|\psi\rangle$ into $|\chi\rangle$ as $F|\psi\rangle = |\chi\rangle$. Represent $\hat{F}$ as a matrix elements in A-representation. **[8]**

b) i) Show that det $e^A = e^{trA}$. State the conditions on A that must be assumed in your proof. **[4]**

ii) Show that $[J_+, J_-] = 2\hbar J_z$ and $[J_z, J_-] = -\hbar J^-$ **[4]**

Q7) a) For an arbitrary operator $\hat{A}$ show that **[4]**

i) $\hat{A}^t \hat{A}$ is hermitian

ii) $\langle \hat{A}^t \hat{A} \rangle \geq 0$.

b) A particle of mass m is confined in the ground state of a one dimensional box, extending from x=-2L to x=+2L. If the wavefunction of the particle in this state is $\psi(x) = A_o \cos\left(\frac{\pi x}{4L}\right)$, then find the normalization constant A_o. **[4]**

c) Define Dirac-S function and represent it graphically. **[4]**

d) Give physical significance of eigenvalues, eigen functions and expansion coefficients. **[4]**

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Total No. of Questions :7]

SEAT No. :

P2647

[Total No. of Pages :3

[5022]-21

M.Sc.

PHYSICS

PHY UTN- 601:Electrodynamics

(2008 Pattern) (Semester - II)

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 labelled diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables & pocket calculator is allowed.*

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

a) The earth receives about 1300 Watt/m^2 radiant energy from the sun. Assuming the normal incidence, calculate the magnitude of electric field vector in sun light.

Given: $\in_0 = 8.85\times10^{-12}$ $C^2/N\text{-}m^2$ and $\mu_0 = 4\pi\times10^{-7}$ Wb/A-m

b) Two identical bodies move towards each other, the speed of each being 0.9 C. What is their speed relative to each other?

c) Calculate the wave impedance of an e.m. wave travelling through free-space.

Given for free spece $\mu = \mu_0 = 4\pi\times10^{-7}\, Wb/A-m$

and $\in = \in_0 = 8.85\times10^{-12}\, C^2/N-m^2$

d) Calculate the rest mass energy of an electron in eV if it's rest mass is equal to 9.11×10^{-31}kg.

e) Show that the ratio of electrostatic and magnetostatic energy densities $\left(\frac{u_e}{u_m}\right)$ is equal to unity.

f) Describe magnetic interaction between the two current loops.

P.T.O.

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

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

Q3) a) Describe Michelson -Morley experiment with reference to the special theory of relativity. Derive the necessary formula for the fringe shift and comment on the result. **[8]**

b) The magnetic field intensity $\vec{B}$ at a point is given by

$$\vec{\mathrm{B}} = \left(\frac{\mu_0}{4\pi}\right)\int \frac{\vec{j}\times\vec{r}}{r^3}\mathrm{d}\tau.$$

Show that $\left(\vec{\nabla}\times\vec{B}\right) = \mu_0 \vec{j}$ **[8]**

Q4) a) Explain the term e.m. field tensor. Hence obtain an expression for e.m. field tensor $F_{\mu\nu}$. **[8]**

b) Prove that the relativistic addition theorem for velocities: $u_x = \dfrac{u'_x + v}{1 + \dfrac{u'_x \mathrm{v}}{c^2}}$

where $u'_x = \dfrac{dx'}{dt'}$ and $u_x = \dfrac{dx}{dt}$.

Hence show that any velocity added relativistically to 'c' gives resultant velocity 'c', which is Lorentz invariant. **[8]**

Q5) a) What is an oscillating electric dipole? Derive the expression for electric and magnetic field radiations, when the length of the dipole is extremely small as compared with the wavelength of radiation. Hince explain 'radiation resistance'. **[8]**

b) Show that $(\mathrm{C}^2\mathrm{B}^2\text{–}\mathrm{E}^2)$ and $\left(\vec{E}\cdot\vec{B}\right)$ are invariant under Lorentz transformations. **[8]**

Q6) a) State and prove Poynting's theorem. **[8]**

b) Explain the term Hertz potential and show that it obeys inhomogeneous wave equation.

Obtain the electric and mangetic fields in terms of Hertz potential $\vec{Z}$. **[8]**

Q7) a) Explain Minkowski's space-time diagram. **[4]**

b) An electron is accelerated from rest to a speed of 0.9995 C in a particle accelerator. Determine the total energy of electron, if it's rest mass energy is 8.2×10^{-14}J. **[4]**

c) Calculate the electric field associated with a LASER beam having energy density 10^{6} J/cm^{3}. **[4]**

d) Write the expression for Lorentz's and Coulomb's gauges. Hence explain these two conditions. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2648

[Total No. of Pages : 3

[5022]-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) ***Question No.1 is compulsory, 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 tables and electronic calculator is allowed.***

Given :

Rest mass of	$e = 9.109 \times 10^{-31}$ kg
Charge on the	$e = 1.6021 \times 10^{-19}$ coulomb
Plank's consant	$= 6.626 \times 10^{-34}$ Js
Boltzmann constant	$= 1.38054 \times 10^{-23}$ JK^{-1}
Avogadro's number	$= 6.022\times10^{26}(\text{kmole})^{-1}$
Bohr magneton	$= 9.27 \times 10^{-24}$ amp.m^2
lev	$= 1.6021\times10^{-19}$J

Q1) Solve any four questions of the following:

a) The Zeeman components of a 500 nm spectral lines are 0.0116 apart when the magnetic field is 01 Tesla. Find the e/m for electron. **[4]**

b) Calculate Lande g factor for $^3P_1$ term. **[4]**

c) The band origin of a transition in C_2 is observed at 19378 cm^{-1} while the rotational fine structure indicates that the rotational constants in excited state and ground state are $B' = 1.7527\ cm^{-1}$ and $B'' = 1.6326\ cm^{-1}$ respectively. Estimate the position of band head. **[4]**

d) Calculate the Debye specific heat of copper at 10K, given that the Debye characteristic frequency is 6.55×10^{-12}Hz **[4]**

e) 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 atom. **[4]**

f) The concentration of Schottkey defects in an ionic crystal is 2 in 10^{10} at temperature of 200K. Estimate the energy of the vacancy pair. **[4]**

Q2) a) Explain in brief the screw and Edge dislocations in solids **[8]**

b) What are zeeman effects. Explain the experimental arrangement to study it and deduce the expression for frequency wave number shift in spectral line. **[8]**

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

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

Q4) a) Explain the principle and working of typical NMR spectrometer and state its applications. **[8]**

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

Q5) a) Discuss the vibrational modes of 1-D monoatomic lattice of identical atoms hence obtain the dispersion relation. **[8]**

b) Derive an expression for the specific heat of a solid based on Debye model. State its merits. **[8]**

Q6) a) Explain the band origin and band head in relation to the rotational fine structure of electronic vibrational spectra. **[8]**

b) Explain with neat diagram the vibrational course structure indicating ν' progression. **[8]**

Q7) a) What are normal and Umklapp processess? **[4]**

b) What is line broadening. What are the factors responsible for broadening of the spectral line. **[4]**

c) What is phonon. Explain the role of phonon in quantization of elastic waves. **[4]**

d) Deduce the expression for configurational entropy. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2649

[Total No. of Pages : 3

[5022]-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.*

Constants:

1) Boltzmann constant, $k_B = 1.38 \times 10^{-23}$ Joule/^oK
2) Planck's constant, $h = 6.625 \times 10^{-34}$ Joule-sec
3) Avogadro's number, $N = 6.023 \times 10^{23}$ mole^{-1}
4) Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg
5) Gas constant, $R = 1.987$ cal/deg/mole
6) Velocity of light $c = 3 \times 10^8$ m/s

Q1) Attempt any four of the following:

a) What do you mean by **[4]**

i) phase space

ii) phase trajectory

P.T.O.

b) A particle of unit mass is executing simple harmonic motion. Determine its trajectory in phase space. **[4]**

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

d) The table given below shows the energy parameters and corresponding accessible states for two systems 1 and 2:

System 1: E_1=2, 3, 4 units and Ω_1= 5, 25, 75

System 2: E_2= 5, 6, 7 units and Ω_2 = 100, 150, 200

The systems are kept in contact and undergo thermal interactions only. Obtain the distribution for 9(nine) units of energy in the equilibrium state. **[4]**

e) Using canonical ensemble, show that the pressure $\bar{p} = \frac{1}{\beta}\frac{\partial \ln Z}{\partial V}$. **[4]**

f) The molar mass of Lithium is 0.00694 and its density $0.53 \times 10^3 kg/m^3$. Calculate the Fermi energy and Fermi temperature of the electrons. **[4]**

Q2) a) For canonical ensemble, show that the probability of finding the system in a particular microstate & having energy E_r is given by

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

b) State and Prove Liouville's theorem. **[8]**

Q3) a) Obtain Curie's law of paramagnetism, on the basis of canonical ensemble. **[8]**

b) Obtain the Maxwell-Boltzmann velocity dstribution and hence show the ratio of r.m.s. speed v_{rms} to the mean speed $\bar{v}$ to the most probable speed $\tilde{v}_0$ is given by

$$v_{rms} : \bar{v} : \tilde{v}_0 = \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$$ **[8]**

Q4) a) Obtain the expression for Planck's radiation Law for photon gas. **[8]**

b) State and prove equipartition theorem. **[8]**

Q5) a) Discuss the behaviour of sharpness of the probability curve and show that the functional width of maximum in P(E) is given by **[8]**

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

b) Derive the relation for average number of particles in F.D. distribution in the form $\bar{n}_s = \frac{1}{e^{\beta(\epsilon_s - \mu)} + 1}$ **[8]**

Where μ is the chemical potential.

Q6) a) When chemical potential μ=0, show that Bose temperature

$$T_B = \frac{h^2}{2\pi mk}\left(\frac{N}{2.612V}\right)^{2/3}$$ **[8]**

b) Calculate mean energy of fermions at 0K. Hence write ground state pressure . **[8]**

Q7) a) Write a short note on Gibbr paradox. **[4]**

b) Write a note on White-Dwarf. **[4]**

c) Distinguish between microstates and macrostates. **[4]**

d) Explain Boltzmann limit of Boson and Fermion gases. **[4]**

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Total No. of Questions :7]

SEAT No. :

P2650

[Total No. of Pages :2

[5022]-24

M.Sc.

PHYSICS

PHY UT - 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 questions from remaining.*
3) *Figures to the right indicate full marks.*
4) *Use of calculator is allowed.*

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

a) Discuss the conditions of validity of WKB approximation.

b) Show that there is no stark effect in ground state of hydrogen atom.

c) One dimensional harmonic oscillator is perturbed by $H' = \lambda x^4$. Obtain the first order correction in energy in ground state.

d) What is dipole approximation? State the selection rules for electrical dipole transitions.

e) State and prove optical theorem.

f) Discuss harmonic perturbation in detail.

Q2) a) Explain time independent perturbation theory. Obtain first and second order correction in energy for non-degenerate state. **[8]**

b) Determine, in the Born approximation, the effective cross-section of scattering for a spherical potential well:

$V = -V_0$ for $r < a$

and $V = 0$ for $r > a$ **[8]**

Q3) a) Using variational method, obtain the ground state energy of hydrogen atom. The trial wave function is $\psi(r) = Ae^{-\alpha r}$, α-variational parameter. **[8]**

b) What is Green's function? By using it, obtain the expression for scattering amplitude when potential is symmetric. **[8]**

P.T.O.

Q4) a) Develop the time dependent perturbation theory to obtain first order correction to amplitude $a_m^{(1)}(t)$. **[8]**

b) What are identical particles? Discuss the scattering of identical particles. **[8]**

Q5) a) State and prove Fermi Golden rule. **[8]**

b) Using WKB approximation obtain Bohr-Sommerfeld quantization condition. **[8]**

Q6) a) Using the partial wave analysis method, show that the total scattering cross-section for scattering from hard sphere is $4\pi a^2$. Where a is radius of sphere. **[10]**

b) Obtain slater determinant for system of N particles **[6]**

Q7) a) Show that the variational method gives an upper bound to the ground state energy. **[4]**

b) Using WKB approximation, discuss the field emission of electrons. **[4]**

c) Discuss the validity of Born Approximation. **[4]**

d) Obtain antisymmetric wave functions for a system of two electrons. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2651

[Total No. of Pages : 3

[5022]-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, 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 and scientific calculator is allowed.*

Given:

Rest mass of electron : 9.1×10^{-31} kg

Electronic charge : 1.602×10^{-19}C

Planck's constant : 6.62×10^{-34} J-s

Boltzmann constant : 1.38×10^{-8} J-K^{-1}

Avogadro's number : 6.023×10^{-24}A-m^2

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

Permittivity of free space : $8.85\times10^{-12}\dfrac{C^2}{N-m^2}$

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

a) Calculate the energy of an electron below the Fermi level at a temperature of 200 k For F(E)=0.9 and Fermi energy y(E_F) having value 3 eV.

P.T.O.

b) Prove that the wavelength associated with an electron having energy equal to the Fermi energy is given by $\lambda_F = 2\left[\frac{\pi}{3n}\right]^{\frac{1}{3}}$

where ‘n’ is the electron concentration.

c) The London penetration depths for pb at 3k and 7k are 39.6 nm and 173 nm respectively. Calculate the depth at OK.

d) Consider He atom in its ground state(^1S). Its mean radius <r> is equal to 0.53 A°. Density of He is 0.178 kg/m^3 and atomic weight is 4 amu. Estimate the diamagnetic susceptibility of He atom

e) A material having a dielectric constant of 5 is positioned within the region between the parallel plates. Calculate the resuthing polarizability.

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

Q2) a) Use equation $m\left(\frac{dv}{dt}+\frac{v}{\tau}\right)=-$e E for electron drift velocity v. Show that the conductivity at frequency ω is $\sigma(\omega)=\sigma(0)\left[\frac{1+i\omega\hat{i}}{1+\omega^2\hat{i}^2}\right]$ **[8]**

Where $\sigma(o)=ne^2\tau/m$. Symbols have usual meanings.

b) What is Ferroelectric effect? Describe the spontaneous polarization in Barium Titanate. **[8]**

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

b) Explain the following properties of superconductors with the help of suitable diagrams. **[8]**

i) Electrical resistance

ii) Isotope effect

iii) Magnetic field

iv) Meissner effect.

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

b) State and prove Bloch theorem. **[8]**

Q5) a) Explain the classification of metals, semi conductor on the basis of band theory of solids. **[8]**

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

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

i) Exchange energy

ii) Anisotropy energy

iii) Bloch wall energy.

b) For a simple 2-D square lattice, show that kinetic energy of a free electron at the centre of the first Brillouin zone is higher than that of the electron at the midpoint of a side face of a zone by a factor of 2. **[4]**

c) Calculate the number of states available for the electron in a cubical box of side 1 cm lying below an energy of 1 ev. **[4]**

Q7) a) For an atom placed at general lattice site,derive an expression for local field E_{local} **[8]**

b) Explain the Josephson effect in superconductors. **[4]**

c) The critical temperature (Tc) for Hg with isotopic mass 199.5 is 4.185k, Determine its critical temperature when its isotopic mass changes to 203.4 **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2652

[Total No. of Pages : 3

[5022]-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,attempt any four questions from the remaining.*
2) *Draw neat figures wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables and pocket calculators is allowed.*

Q1) Attempt any four of the following:

a) Calculate the half value thickness for β absorption in Aluminium for β spectrum with $E_{min} = 1.17$ MeV. Given density of Aluminium=2700 kg1m^3. **[4]**

b) Show that the electrical quadrapole moment of a charge τ_e, over a ring of radius R can be expressesd in terms. **[4]**

c) In a Bainbridge and Jordon mass spectrometer singly ionized atoms of Ne.20 pass the deflection chamber with a velocity of 10^5 m/s. If they are dettected by a magnetic field of flux density 0.08 tesla, calculate the radius of their path and where neon 22 ions would fall if they had the same initial velocity. **[4]**

[Given mp = 1.67×10^{-27}kg]

d) Estimate the distance of closest approach of 2MeV proton to a gold Nucleus. How does this distance compare with those for a deuteron and α particle of same energy. **[4]**

Given-τ for gold nucleus=79, e=1.6×10^{-19}c, $\frac{1}{4\pi\epsilon_0} = 9\times10^9$ Nm^2/c^2

P.T.O.

e) Explain why experimentally the study of p-p scattering capable of much higher accuracy than p-p scattering. **[4]**

f) Calcualte parity, electric quadrapole moment and magnetic dipole moment for the element ${}_{16}S^{33}$ **[4]**

Q2) a) Explain the working of proportional counter. State its advantages and application. **[8]**

b) Explain the concept of quadrapole moment and derive an expression for the same and show that it is zero for spherical distribution of charges. **[8]**

Q3) a) Describe the shape independent effective range scattering theory and obtain the expression for cross- section in terms of effective Range. **[8]**

b) Write a note on collective model of the Nucleus. **[8]**

Q4) a) Discuss electron scattering method to determine the size of a nucleus. **[8]**

b) State important features of Fermi-theory of decay and find the probability of emission per unit time for the electron. **[8]**

Q5) a) Explain the terms-Hypercharge, isospin and strangness for elementary particles. State any two conservation Laws of them. **[8]**

b) For p-p scattering at law energies, derive an expression for differential cross- section in Laboratory system. **[8]**

Q6) a) Describe Gamow's theory of alpha decay. Hence deduce Geiger-Nuttall Law. **[8]**

b) Outline briefly the phase shift analysis in p-p scattering. Hence derive the expressions for **[8]**

i) scattering cross section and

ii) Scattering amplitude.

Q7) a) Write a note on Graphite moderated Research reactor. **[4]**

b) Define and explain the term effective Range. **[4]**

c) Discuss the brief production and properties of pion. **[4]**

d) Explain the concept of iso-spin associated with elementary particle. **[4]**

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