Total No. of Questions :7]

SEAT No. :

P2726

[Total No. of Pages :3

[5529]-11

M.Sc.

PHYSICS

PHY UT 501 : CLASSICAL MECHANICS

(2008 Pattern) (Semester - I)

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

Q1) Attempt any Four of the following.

a) A bead slides on a smooth rod which is rotating about one end in a vertical plane with uniform angular velocity 'ω'. Show that the equation of motion is $m\ddot{r} = mr\omega^2 - mg\sin(\omega t)$ **[4]**

b) Prove that generating function $F = \sum q_k P_k$, generates identity transformation. **[4]**

c) Apply the principle of virtual work to obtain lever equation. **[4]**

d) Use Hamilton's equation to prove that the areal velocity is constant in planery motion. **[4]**

e) Write down the Hamiltonian for spring mass system and obtain its equation of motion. **[4]**

f) Write equations of constraints for **[4]**

i) Simple pendulum with variable length

ii) A particle moving on or outside surface of sphere

P.T.O.

Q2) a) Write down the Lagrangian for compound pendulum and obtain its equation of motion. **[8]**

b) Deduce Hamiltonian for simple pendulum and obtain its equation of motion. Also calculate the period of its oscillation. **[4]**

c) State and prove viral theorem. **[4]**

Q3) a) A particle describes a circular orbit under the influence of an attractive central force directed towards a point on the circle. Show that the force varies as the inverse fifth power of the distance. **[8]**

b) The transformation equation between two sets of coordinates are $P = 2\left(1+q^{1/2}.\cos p\right)q^{1/2}\sin p$ and $Q = \log\left(1+q^{1/2}\cos p\right)$.

Show that i) The transformation is canonical

ii) The generating function of this transformation is $F = -\left(e^{Q}-1\right)^{2}\tan p$. **[8]**

Q4) a) A pendulum of mass 'm'is attached to a block of mass 'M'. The block slides on a horizontal frictionless surface. Find the Lagrangian and equation of motion of the pendulum. For small amplitude oscillation, derive an expression for periodic time. **[8]**

b) What is Focault's pendulum? Obtain its equation of motion. **[8]**

Q5) a) Prove that $[F, G]_{q,p} = [F, G]_{Q,P}$ using Poisson's bracket. **[8]**

b) Drive Euler-Lagrange equation and using variational principle show that geodesics of a spherical surface are great circles. **[8]**

Q6) a) Obtain an expression for Coriolis acceleration for rotating co-ordinate system. **[8]**

b) Write note on artificial satellite. **[4]**

c) Prove the distribution law and multiplication law for Poisson's bracket. **[4]**

Q7) a) A disc of radius 'a' and mass 'm' rolls down an inclined plane making an angle θ with the horizontal. Setup the Lagrangian and find the equation of motion and acceleration of the disc. **[8]**

b) Deduce Hamiltonian for one dimensional harmonic oscillator and obtain its equation of motion. **[4]**

c) Show that the function $F = -\sum Q_i p_i$ generates the identity transformation. **[4]**

Total No. of Questions :7]

SEAT No. :

P2727

[Total No. of Pages :2

[5529]-12
M.Sc.
PHYSICS
PHYUTN502: Electronics
(2008 Pattern) (Semester - I)

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

Instructions to the candidates:

1) ***Question No. 1 is compulsory and attempt any Four questions from the remaining.***
2) ***Figures to the right indicate maximum marks.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Use of logarithrmic table and electronic pocket calculator is allowed.***

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

a) Design a $\pm$ 5V regultted power supply using three pin ICS. **[4]**

b) If logic 'l'=8V & logic '0'=ov, then determine the following for R-2R type 4 bit DAC.

i) Analog output voltage for input 1001

ii) Voltage resolution. **[4]**

c) Explain with neat circuit diagram, the working of sample and hold circuit. **[4]**

d) State any four characteristics/parameters of OPAMP. State their values for ideal OPAMP and IC 741. **[4]**

e) Design first order, Butterworth low pass for frequency of 5KHz. Draw its circuit. **[4]**

f) What is PLL? Draw its block diagram. Define **[4]**

i) Capture Range ii) Locking Range

Q2) a) Explain with neat circuit diagram, the operation of Astable Multivibrator using IC555.

Design the circuit for f_0 = 2KHz if c=0.01 μf and Vce=+10V with duty cycle of 50% **[8]**

b) What is Instrumentation Amplifier? Derive the expression for its output voltage using three OPAMP. what are the advantages (at least 2) of an instrumentation amplifier over amplifier? **[8]**

P.T.O.

Q3) a) Draw the a function diagram of 4 bit shift register using IC 7495. Explain its working with night and left shift operation for a data 1010 with necessary timing diagram/wave form. **[8]**

b) What is meant by precision Rectifier? Explain with neat circuit diagram, the working of a full-wave precision rectifier using OPAMP. Draw its input and output waveforms. **[8]**

Q4) a) Draw a block diagram of IC723 voltage regulator. Design a voltage regulator for 5V output with current of 0.1A, using IC723 voltage regulator. Draw its circuit diagram. **[8]**

b) Draw a combinational logic circuit to implement following expression.

$Y=\sum_{m}(0,2,4,5,8,10,12,15)$ How it can implemented using multiplexer? **[8]**

Q5) a) With neat block diagram, state the function of each block of function generator IC 8038. Design this function generator for output frequency of 10 KHz. **[8]**

b) What is VCO? Explain its working with neat block diagram of IC 566.

Design VCO using IC 566 to generate a wave form ferquency range from 2KHz to 10 KHz (Given Vcc = 10v.) **[8]**

Q6) a) What is decade counter? State its applications. How IC7490 decade counter can be used to construct MOD.5 counter? **[8]**

b) Design a notch filter using twin -T network, for f_n = 50Hz and Q=5. Determine its f_h,f_l and bandwidth. Draw its frequency response curve. **[8]**

Q7) Write short notes on any four of the following: **[16]**

a) Monostable multivibrator using IC 74121.

b) Frequency spectrum –MW,SW,FM,LHF and its application.

c) Counter type ADC.

d) Karnaugh map and its use in BCD to gray code conversion.

e) Switching mode power supply.

f) Binary Weighted Resistor type DAC (4bit)

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Total No. of Questions : 7]

SEAT No. :

P2728

[Total No. of Pages : 3

[5529]-13

M.Sc.

PHYSICS

PHY UTN-503 : Mathematical Methods in Physics

(2008 Old 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 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: **[4]**

$$W = \{(a,b,c) : a^2 + b^2 + c^2 \le 0\}$$

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

c) State and explain the Dirichlet conditions. **[4]**

d) Determine the residue of **[4]**

$$\frac{ze^{zt}}{(z-3)^2} \text{ at } z = 3$$

e) Prove that: **[4]**

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

f) Obtain the first two Hermite's polynomials. **[4]**

P.T.O.

Q2) a) Let V be the vector space of polynomials with inner product given by $\langle f,g\rangle = \int_0^1 f(t)\, g(t)\, dt$. Let $f(t) = t + 2$ and $g(t) = t^2 - 2t - 3$. Find $\langle f,g\rangle$ and $\|f\|$. **[8]**

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

Q3) a) State and prove Laurent's theorem. **[8]**

b) Using the Rodrigue's formula for Laguerre's polynomials obtain the first three Laguerre polynomials. **[8]**

Q4) a) State Residue theorem. Explain how the Cauchy's theorem and integral formulas are special cases of residue theorem. **[8]**

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

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

b) Find eigenvalues and eigenvectors of matrix $A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$. **[8]**

Q6) a) Find the Fourier transform of: **[8]**

$$f(x) = 1 \quad |x| < a$$
$$f(x) = 0 \quad |x| > a$$

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: **[8]**

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

ii) $\{f_1 = (1,3),\ f_2 = (2,5)\}$.

Q7) a) State and prove Parseval's identity for Fourier series. **[4]**

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

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

d) Let $f(t)$ be continuous and have a piecewise continuous derivative $f'(t)$ in every finite interval $0 \le t \le T$. Suppose also that $f(t)$ is of exponential order for $t > T$. Then prove that: **[4]**

$$L\{f'(t)\} = s\,L\{f(t)\} - f(0).$$

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Total No. of Questions : 7]

SEAT No. :

P2729

[Total No. of Pages : 3

[5529]-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 1 is compulsory, Attempt four from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators allowed.***

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

a) Prove that $[x^n, p] = i\hbar n x^{n-1}$, where x and p are position and momentum operators.

b) Prove that $\left[L_x, L_y\right] = i\hbar L_z$ and $\left[L+, L-\right] = 2\hbar L_z$.

c) Show that the Pauli spin matrices satisfy the commutation relation $\left[\sigma^2, \sigma_z\right] = 0$.

d) Explain Hilbert space in detail.

e) Using uncertainty principle estimate ground state energy of harmonic oscillator.

f) For $j = ½$, obtain the matrix Jx.

P.T.O.

Q2) a) Establish Schrödinger equation for an infinite deep potential well and obtain eigen functions and eigen values. **[8]**

b) Explain completeness and closure property of eigen functions. **[8]**

Q3) a) Explain Heisenber picture. Show that **[8]**

$$i\hbar\frac{d\mathrm{A}}{dt} = [\mathrm{A},\mathrm{H}] + i\hbar\frac{\partial \mathrm{A}}{\partial t}$$

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

Q4) a) Using ladder operators obtain energy eigen values of one dimensional harmonis oscillator. **[8]**

b) Explain Hermitian operator. Show that eigen functions corresponding to distinct eigen values of Hermitian operator are orthogonal. **[8]**

Q5) a) Define norm and scalar product in Hilbert space for arbitrary vectors $|\psi\rangle$ and $|x\rangle$. Prove that **[8]**

i) $\left\langle a\middle|\hat{\mathrm{A}}\middle|a\right\rangle = a'\delta aa'$

ii) if $\langle\psi|\psi\rangle = 1$ and U is unitary prove that $\langle \mathrm{U}\psi|\mathrm{U}\psi\rangle = 1$.

b) Show that momentum operator is Hermitian **[8]**

Q6) a) Using as a basis of eigen vectors $|jm\rangle$ of J^2 and J_z, obtain matrix representation of the angular momentum operators J_x, J_y and J_z. **[8]**

b) Define projection operator. Show that the sum of all projection operators leaves any state vector $|\psi\rangle$ unchanged. **[8]**

Q7) a) Show that $(x\,p_x)^2 \neq x^2 p_x^2$, where x and p_x are position and momentum operators respectively. **[4]**

b) If A is anti-Hermitian, show that e^A is unitary. **[4]**

c) Show that Hermitian operator retains its Hermitian characteristics under unitary transformation. **[4]**

d) If ψ_1 and ψ_2 are eigen functions of an operator then prove that their linear combination is also a eigen function of the same operator. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2730

[Total No. of Pages : 2

[5529]-21
M.Sc. - I
PHYSICS
PHYUTN-601 : Electrodynamics
(2008 Pattern) (Semester - II)

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

Instructions to the candidates:

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

Q1) Attempt any four of the following :

a) Write Maxwell's equations in differential and integral forms. **[4]**

b) Explain the term 'momentum space' with the help of suitable example. **[4]**

c) Calculate the frequency at which the skin-depth in sea water is 1 meter.

Given : $\mu_0 = \mu = 4\pi \times 10^{-7} \dfrac{\text{Wb}}{\text{A}-\text{m}}$ and $\sigma = 4.3 \dfrac{\text{mho}}{\text{m}}$. **[4]**

d) Show that the ratio of electrostatic and magnetic energy densities is equal to unity. **[4]**

e) Determine the velocity at which the mass of a particle is double its rest mass. Given : $C = 3 \times 10^8$ m/s. **[4]**

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

Q2) a) Derive an expression for potential at a distant point using multipole expansion for a localized charge distribution in free space. **[8]**

b) Describe Michelson-Morley experiment wth a suitable diagram. Hence derive the formula for fringe shift. **[8]**

Q3) a) Using the concept of e.m. energy, show that power transferred to the e.m. field through the motion of charge in volume V is given by : **[8]**

$$-\int_{V}\left(\vec{j}.\vec{E}\right)dV = \frac{d}{dt}\int_{V}\frac{1}{2}\left(\vec{E}.\vec{D}+\vec{B}.\vec{H}\right)dV + \int_{CS}\left(\vec{E}\times\vec{H}\right)ds$$

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

P.T.O.

Q4) a) With the help of suitable diagram explain the magnetic interaction between two current loops. **[8]**

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

Q5) a) The magnetic field intensity $\vec{B}$ at a point is given by : **[8]**

$\vec{B}=\left(\frac{\mu_0}{4\pi}\right)\int \frac{\vec{j}\times\vec{r}}{r^3}dr$, show that $\vec{\nabla}\times\vec{B}=\mu_0 j$.

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

Q6) a) Calculate the magnitude of Poynting's vector at the surface of the sun.

Given : Power radiated by sun is equal to 3.8×10^{26} Watt and radius of the sun is equal to 7×10^8 m. **[8]**

b) Prove that the space interval $x^2 + y^2 + z^2$ is not invariant under Lorentz transformations, while combined space-time interval $x^2 + y^2 + z^2 - c^2t^2$ is Lorentz invariant. **[8]**

Q7) a) Explain the term ' Skin Effect' and 'Skin Depth'. **[4]**

b) Find the velocity at which the mass of the particle is double its rest mass. Given : $C = 3 \times 10^8$ m/s. **[4]**

c) Explain the term 'Four Vector Potential'. **[4]**

d) Find the wave impedance of an e.m. wave travelling through free space.

Given : $\mu_0 = 4\pi\times10^{-7}\frac{\text{Wb}}{\text{A}-\text{m}}$ & $\in_0 = 8.85\times10^{12}\frac{\text{C}^2}{\text{N-m}^2}$. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P2732

[Total No. of Pages : 3

[5529]-23

M.Sc.

PHYSICS

PHY UTN-603 : Statistical Mechanics in Physics

(2008 Pattern) (Semester-II) (Old)

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) ***Boltzman's constant*** $k_B = 1.38 \times 10^{-23}$ ***Joule/°k.***
2) ***Plank'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 me*** $= 9.1 \times 10^{-31}$ ***kg.***
5) ***Velocity of light*** $c = 3 \times 10^{8}$ ***m/s.***

Q1) Attempt any four of the following:

a) Explain macrostate and microstate of a system. **[4]**

b) Obtain the mean energy of femions at absoute zero. **[4]**

c) The energy of particle moving in a rigid cubical box is specified by the equation. **[4]**

$$n_x^2 + n_y^2 + n_z^2 = \frac{2mc^2 \mathrm{E}}{n^2 h^2} = 14$$

Determine the number of microstates accessible to the particle.

d) What is mechanical interaction? **[4]**

e) Compare the basic postmasters of B.E. and F.D. Statistics. **[4]**

P.T.O.

Q2) a) State and prove equipartition theorem. **[8]**

b) Show that photons the mean pressure $\langle P \rangle$ is related to its total energy E is given by the relation $\langle P \rangle = \frac{1}{3}\frac{\langle E \rangle}{V}$. **[8]**

Q3) a) State and prove Lianville's theorem in classical statistics. **[8]**

b) For grand cannonical ensemble, show that probability of finding the system in a particular microstate "r" having Energy E_r and number of particles N_r is given by $P_r = \frac{e^{-\beta E_r - \alpha N_r}}{\sum_r e^{-\beta E_r - \alpha N_r}}$. **[8]**

Q4) a) Calculate the mean values $\overline{E}$ and $\overline{(\Delta E)^2}$ for canonical enesmble in terms of partition function. **[8]**

b) On the basis of canonical distribution, obtain the law of atmosphere $p(z) = p(0)e^{-mg^2/kT}$. **[8]**

Q5) a) Use canonical distribution to discuss the behavior of paramagnetic substance placed in an external magnetic field. Hence obtain magnetic susceptibility of para-magnetic substance. **[8]**

b) State the expression for quantum distribution function $\overline{n_S}$ and obtain BE distribution in the form $\overline{n_S} = \frac{1}{e^{\beta(\in S - \mu) - 1}}$ where μ is chemical potential. **[8]**

Q6) a) Obtain Maxwell's velocity distribution and hence show that the radio of root mean square velocity $v_{\max}$ to mean velocity $\overline{v}$ to the most probable velocity $\overline{v}$ is given by $v_{\max} = \overline{v} : \overline{v} \equiv \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$. **[8]**

b) In case of Bose-Einstein condensation for $T < T_B$ prove that $N = N_0 + N\left(\frac{T}{T_B}\right)^{3/2}$ where. **[8]**

N = total Number of particles and

N_0 = total number of particles in ground state.

Q7) a) Show that for diatomic molecule when $T \ll \theta v$ where θ_v is the vibrational characteristics temperature $(Cv)_{vib} = N_k \left(\frac{\theta v}{T}\right)^2 e^{-\theta v/T}$. **[8]**

b) Derive the expression of Stefan's law for Black Body radiation. **[8]**

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Total No. of Questions : 7]

SEAT No. :

P2733

[Total No. of Pages : 2

[5529]-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. Solve any four from remaining.*
2) *Draw neat diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of log-tables and calculators allowed.*

Q1) Attempt any four of the following:

a) Define exchange operator. Show that eigen values of exchange operator are ± 1. **[4]**

b) Discuss the selection rules for dipole transitions. **[4]**

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

d) The harmonic oscillator is perturbed by $H^1 = bx^3$. Obtain first order correction in energy for ground state. **[4]**

e) Explain Laboratory and Centre of mass frames of reference. **[4]**

f) Find the energy levels and eigen functions of Hamiltonian $H = \begin{bmatrix} 1+\varepsilon & \varepsilon \\ \varepsilon & 1+\varepsilon \end{bmatrix}$. Where $\varepsilon << 1$, corrected upto first order in ε using perturbation theory. **[4]**

Q2) a) Starting from perturbation state, obtain first order corrections in energy in case of stationary degenerate states. **[8]**

b) Write down connection formulae in WKB approximation. Hence obtain Bohr-Sommerfield quantization rule. **[8]**

P.T.O.

Q3) a) Using partial wave analysis, obtain the expression for scattering amplitudes and total scattering cross-section. **[8]**

b) Obtain Slater determinant for system of N electrons. **[8]**

Q4) a) Show that the Born scattering amplitude is proportional to the spatial Fourier transform of the scattering potential with respect to the momentum transfer. **[8]**

b) What is Harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[8]**

Q5) a) Apply variational method to estimate the ground state of a hydrogen atom (Use trial wave function $\mathrm{N}(r) = \overline{e}^{\alpha r}$, where α is variational parameters). **[8]**

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

Q6) a) Use WKB approximation to illustrate the of alpha-decay from radioactive nucleus. **[8]**

b) What are identical particles? Obtain symmetric and anti-symmetric wave functions for a system of two electrons. **[8]**

Q7) a) State the conditions of validity of Born approximation for scattering. **[4]**

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

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

d) State the condition of validity of WKB approximation. **[4]**

Total No. of Questions : 7]

SEAT No. :

P2734

[Total No. of Pages : 3

[5529]-31

M.Sc.

PHYSICS

PHYUTN-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 diagrams wherever necessary.*
4) *Use of logarithmic table and pocket calculator is allowed.*

Given :

Mass of electron = 9.1×10^{-31} Kg

Charge of electron = 1.6×10^{-19} C

Plank's constant = 6.626×10^{-34} J-s

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

Avogadro's number = 6.023×10^{26} / Kmol

Bohr magneton = 9.27×10^{-24} A-m^2

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

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

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

a) Show that for Kronig - Penny potential with p<<1 the energy of the lowest energy band at k = 0 is $E = \hbar^2 p / ma^2$.

b) A paramagnetic material is subjected to a homogeneous field of 10^6 A/m at 37ºC. Calculate the average magnetic moment along the field direction per spin in Bohr magneton.

c) Calculate the critical current density 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.

d) Estimate the fraction of electrons excited above Fermi level at 27ºC for sodium and copper if Fermi level values are $E_F = 3.1$ eV for sodium and $E_F = 7$ eV for copper.

P.T.O.

e) A circular loop of conductor having a diameter of 0.5 m carries a current of 10^5 μA. Calculate the values of magnetic dipole moment. The loop is placed in a magnetic field having a uniform flux density of 0.05 Wb/m^2 with its axis inclined at 60º to the direction of field. Hence calculate the torque experienced by the current loop.

f) The relative permittivity of argon at 0ºC and one atmosphere is 1.000435. Calculate the polarizibility of the atom.

Q2) a) Derive London's equation for super conducting state and obtain an expression for London's penetration depth. **[8]**

b) Discuss the origin of diamagnetism in a free atom. Obtain Langevin's diamagnetism equation for the diamagnetic susceptibility. **[8]**

Q3) a) Describe the motion of electron in one dimensional periodic potential. Explain the concept of effective mass m*. Draw E-K, V-K and m*-K diagrams. **[8]**

b) Define polarizibility in dielectrics. Explain different types of polarizibilities. Represent total polarizibility as a function of frequency graphically. **[8]**

Q4) a) Give an account of Weiss theory of ferro-magnetism and show from the plot of Langevin's function, spontaneous magnetization exists below the Curie temperature and vanishes above the Curie temperature. **[8]**

b) Define dielectric function of the free electron gas. Derive the expression for plasma frequency. **[8]**

Q5) a) For antiferromagnetic substances, prove the following relation for Neel temperature

$$\frac{T_N}{\theta} = \frac{\lambda_{ij} - \lambda_{ii}}{\lambda_{ij} + \lambda_{ii}}$$

Symbols have usual meaning. **[8]**

b) State Bloch theorem. Prove it for the function φ_K for a general potential at value K. **[8]**

Q6) a) Explain the assumptions of BCS theory of superconductivity. **[8]**

b) i) Explain the concept of Bloch wall with reference to magnetism. **[4]**

ii) What are the assumptions of nearly free electron model. **[4]**

Q7) a) Write expression for F-D statistics and explain how it changes with temperature. **[4]**

b) A magnetic material has a magnetization of 3300 A/m and magnetic flux density of 4.4×10^{-3}T. Calculate the magnetizing force. **[4]**

c) Explain flux quantization in super conducting ring. **[4]**

d) Draw diagrams for Fermi surfaces in first, second and third Brillouin zones. **[4]**