First Year M.Sc., (Physics), Examination

August / September 2009

Directorate of Distance Education

(Freshers)

Physics

Paper - I : Mathematical Methods and Classical Mechanics

Time : 3 Hours Max. Marks : 85

Note : Answer any FIVE questions from Part A , B and C withour omitting any prt. Part D is compulsory

PART- A

1. a. What are singular points of a complex function f(z) ? Explain with examples different kinds of singularities.

   b. Define residue of a function. Find the residues of the following functions at their poles

   (i) $f(z) = \frac{1}{(z-2)^2}$ (ii) $f(z) = \frac{e^{iz}}{z^2+1}$ **(7+6)**

2. a. Write down Legendre differential equation and generating function for Legendre polynomials.

   b. Show that $J_{-n}(x) = (-1)^n J_n(x)$ where $J_n(x)$ is Bessel function.

   c. Arrive at the orthogonality relations for Hermite polynomials. **(2+3+8)**

3. a. Explain the concept of gradient of a scalar functions and divergence of a vector function with examples.

   b. Evaluate the line intergral $\int_C \vec{a}.\vec{dr}$ where $\vec{a} = (x+y)\vec{i} + (y-x)\vec{j}$ along the parabila $y^2 = x$ from (1,1) to (4,2).

   c. Write down the expression for Laplacian operator in terms of spherical and cylindrical coordinates. **(6+5+2)**

PART- B

4. a. Define hermitian and unitary matrices. Give examples.

   b. Diagonalize the following matrix. **(4+9)**

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

5. a. Define first rank and second rank cartesian tensors.
   b. Show that the Kronecker delta symbol is a mixed tensor of rank two.
   c. Give an account of tensors in physics. **(2+6+5)**

6. a. Express the following function as a Fourier series.
   $f(x) = -1$ for $-\pi \le x < 0$
   $= 1$ for $0 \le x < \pi$
   b. Show that the Fourier transform of f (ax) is given by $\frac{1}{|a|} F\left(\frac{w}{a}\right)$ where F(w) is the Fourier transform of f(x) and $a \neq 0$
   c. If f (s) is the Laplace transform of a function F(t), express the Lapalace transform of $\frac{dF(t)}{dt}$ in terms of f(s). **(6+4+3)**

PART- C

7. a. Discuss the motion of a system of particles when there are no external forces and external torques acting on it.
   b. State and explain D' Alembert's principle. **(9+4)**

8. a. What do you mean by the constrained motion of a system of particles? Classify the different kinds of constraints giving examples for each kind.
   b. If $L = \frac{1}{2} m (q_1^2+q_2^2) - \frac{1}{2} k (q_1 - q_2)^2$; is the Lagrangian of a system of two particles, obtain the Lagrange's equations of motion of the second kind.
   c. What are cyclic coordinates? Give an example of a system having a cyclic coordinate. **(6+4+3)**

9. a. Arrive at Hamilton's equations of motion.
   b. Define Poisson bracket of two functions of position and momentum. If $A = p\text{-}q^2$ and $B = q\text{-}p^2$ find their Poisson bracket. **(9+4)**

PART- D

(4x5=20)

10. a. If $L = \frac{1}{2} m (\dot{r}^2 + r^2 \dot{\theta}^2 + r^2 \dot{\phi}^2 \sin^2 \theta) - \frac{\lambda}{r^2}$ is the Largrangian of a system, find its Hamiltonian and obtain Hamilton's equations of motion.
    b. Find the Fourier cosine transform of Exp (-x)
    c. Expand the function f(z) in a Taylor series about the point z=0.
    $$f(z) = \frac{1}{(1+z)^2}$$
    d. Express the following matrix as the sum of a hermitian and a skew - hermitian matrix.
    $$\begin{pmatrix} 2 & 2i & 1+i \\ 1-i & 1 & 3 \\ -2i & 3 & -i \end{pmatrix}$$
    e. Evaluate the curl of $\vec{a}$ at the point (1, 0 -1).
    $\vec{a} = (x+y^2)\hat{i} + (y+z^2)\hat{j} + (z+x^2)\hat{k}$

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First Year M.Sc., (Physics), Examination

August / September 2009

Directorate of Correspondence Course

(Freshers)

Physics

Paper - II : Quantum and Statistical Mechanics

Time : 3 Hours

Max. Marks : 85

Note : Answer any FIVE questions from Part A , B and C without omitting any part. Part D is compulsory

PART- A

1. a. Explain how a linear operator acting on a vector space is represented by a matrix in certain basis.

   b. Obtain the transformation rule for the matrix of a linear operator under a change of basis. **(8+5)**

2. a. Obtain the uncertainty relation for two observables $\hat{A}$ and $\hat{B}$ satisfying $[\hat{A}, \hat{B}] = i\hat{C}$

   b. Show that the hermitian conjugate of the product of several operators is the product of their hermitian conjugates in the reverse order. **(8+5)**

3. a. List the basic postulates of quantum mechanics.

   b. Obtain the equivalent of Newton's second law in quantum mechanics using Ehrenfest's theorem.

   c. Show that $[\hat{x}, \hat{p}_x] = i\hbar$ **(4+7+2)**

PART- B

4. a. Starting from the time independent Schrodinger equation for a one dimensional harmonic oscillator, arrive at the Hermite differential equation and hence obtain the energy eigenvalues.

   b. Show that the two-body Schrodinger equation of Hydrogen atom can be transformed to single body equations. **(7+6)**

5. a. Discuss the coupling of two independent angular momenta and explain how the coupled basis states are related to the product basic states.

   b. Given the three orthonormal single particle wave functions ϕ_α, ϕ_β and ϕ_γ of a fermion, construct the completely antisymmetric state of three such identical fermions. **(8+5)**

6. a. Estimate the ground state energy of the Helium atom using variational method.
   b. Arrive at the Fermi golden rule for transitions under harmonic perturbation. **(7+6)**

PART- C

7. a. Explain the meaning of i) Microstate ii) Macrostate iii) Ensemble in statistical mechanics.
   b. Mention the postulate of equal apriori probability.
   c. State and prove Liouville's theorem. **(6+3+4)**

8. a. Explain Gibb's paradox.
   b. Obtain the Sackur Tetrode formula.
   c. Show that the two quantum distribution functions reduce to Maxwell's distribution function at high temperature. **(5+4+4)**

9. a. Obtain an expression for the distribution function at equilibrium for bosons.
   b. Arrive at Dulong and Petit's law using statistical mechanics. **(8+5)**

PART- D

10. **Answer the following** **(4x5=20)**
    a. Find the eigenvalues of $A = \begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$
    b. Find the normalization constant N for the wavefunction $\psi(x) = N \exp(-bx^2)$, where b is a real constant.
    c. Find the parity of the spherical harmonics $Y_{lm}(\theta,\phi)$
    d. Show that the energy of the ground state of a system never exceeds the expectation value of energy for any state.
    e. Give the statistical interpretation of entropy

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First Year M.Sc., (Physics), Examination

August / September 2009

Directorate of Distance Education

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Physics

Paper - III : Solid State Physics

Time : 3 Hours Max. Marks : 85

Note : Answer any FIVE questions from Part A , B and C without omitting any part. Part D is compulsory

PART- A

1. a. What is space lattice? Define primitive cell and unit cell.
   b. What are Miller indices? Explain with examples.
   c. Explain the crystal structure of NaCl and Diamond. **(4+4+5)**
2. a. Mention the properties of reciprocal lattice vectors and show that reciprocal lattice vector of BCC is a direct lattice vector of FCC.
   b. Explain Bragg law and derive the Bragg's equation for X-ray diffraction. **(7+6)**
3. a. What are the types of magnetic materials? Describe the Langevin's theory of diamagnetism.
   b. Describe the Rotating - Crystal method of X- ray diffraction and calculate the interplanar spacing for (212) plane in a simple cubic lattice where lattice constant a = $4.6A^0$ **(6+7)**

PART- B

4. a. What is Meissner effect? Obtain the thermodynamic relations of specific heat and entropy at different magnetic fields of a superconductor.
   b. Describe the type I and type II superconductors. **(8+5)**
5. a. Mention different kinds of polarization and explain the dipolar polarizability.
   b. Obtain the Clausius- Mosotti relation for molar polarizability. **(7+6)**
6. a. Describe the thermionic emission and derive the Richardson's equation.
   b. Explain Hall effect and mention salient features of Hall constant(R_H) **(8+5)**

PART- C

7. a. State the Bloch theorem and Obtain the velocity of Bloch electron and it effective mass. Also draw the plots of V versus K and m^* versus K.

b. Distinguish between metals, insulators and semiconductors on the basis of band diagram. **(8+5)**

8. a. Obtain an expression for electrical conductivity of electrons and holes in terms of their mobility in the applied electric field and discuss temperature dependence of the conductivity.

b. Derive a relation for density of holes in valence band and discuss the Fermi level of intrinsic semiconductor. **(7+6)**

9. a. What are the point defects? Obtain the expression for number of Schottky defects in an ionic crystal.

b. Explain the Burgers vectors and describe the Czochralaski method of crystal growth. **(7+6)**

PART- D

10. **Write explanatory notes on the following.** **(4x5=20)**

a. Metallic and ionic bonding

b. Weiss molecular filed theory

c. London equations.

d. Electronic specific heat.

e. Kroning - Penney model

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DPA 540

First Year M.Sc., (Physics), Examination

August / September 2009

Directorate of Distance Education

(Freshers)

Physics

Paper - IV : Electronics

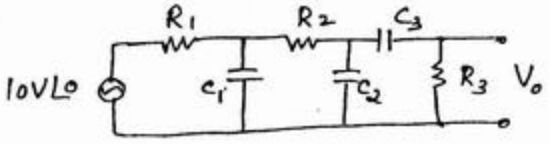
Time : 3 Hours

Max. Marks : 85

Note : Answer any FIVE questions from Part A , B and C without omitting any part. Part D is compulsory

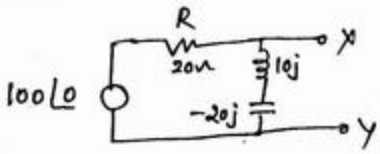
PART- A

1. a. Evaluate the voltage across R_3 in the following network using mesh current method. Will the output voltage V_0 is in phase or out of phase with inpuit voltage?



b. Find the Norton's equivalent circuit of the following circuit with respect to terminals XY

(9+4)



2. a. Derive the expressions for cut off frequency of the constant K type filter of the following type.
   1) High pass T section
   2) Low pass π section

   b. An m - derived T section high pass filter has a cut-off frequency of 100KHz with a design impedance of 500 Ω and m = 0.3. Calculate the series and shunt arm elements.

(10+3)

3. a. Solve the differential equations for voltage and current on a line of distributed parameters and hence give the physical significance of these equations. Explain when the line becomes an infinite line.

   b. What is impedance mismatch?

(10+3)

PART- B

4. a. Explain the following terms with respect to a pn junction
   1) avalanche breakdown
   2) zener breakdown
   b. Write a note on opto-isolators. **(8+5)**

5. a. Compare the characteristics of the three basic configurations of a transistor amplifier.
   b. Explain the self - biasing of a transistor circuit. **(10+3)**

6. a. Describe the working of a wien-bridge oscillator with the help of a circuit.
   b. Derive the condition for self sustained oscillations and an expression for the frequency of oscillations in the above oscillator.
   c. Write briefly an multivibrators. **(2+7+4)**

PART- C

7. a. Compare the characteristics of an ideal and practical operational amplifier.
   b. Show that an op-Amp performs the algebraic operations of addition and subtraction.
   c. Write a note on active filters. **(3+7+3)**

8. a. Explain how can a scale changer and phase shifter be obtained with an op-Amp.
   b. Convert the following decimal numbers into equivalent octal numbers
   (1) 237 (2) 6327.45 (3) 0.75 (4) 334.05
   c. Write on BCD code **(5+5+3)**

9. a. What is the difference between a half adder and a full adder? Give the truth table of half and full adders and explain them. Show that a full adder can be realized using half adder.
   b. Realize a following operation using only NOR gates and only NAND gates.
   $L = M\overline{N} + \overline{M}N$ **(8+5)**

PART- D

10. **Write short notes on the following** **(4x5=20)**
    a. Noton's theorem (with an example)
    b. Advantages of active filters over passive filters
    c. Silicon controlled rectifier (SCR)
    d. Feedback principle
    e. Karnaugh maps.

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