DPA – 510 PHY (F)

M.Sc. (Previous) Examination, August/September 2008
PHYSICS
Directorate of Correspondence Course (Freshers)
Paper – I : Mathematical Methods and Classical Mechanics

Time : 3 Hours Max. Marks : 85

***Note** : Answer Part D. Answer any **FIVE** question from Part A, B and C without omitting any Part.*

PART – A

1. If f(Z) is analytic at all points inside a circular domain D with its centre at $Z = Z_0$ and radius r_0 then prove that for every Z inside D

$$f(Z)=\sum_{n=0}^{\infty}\frac{f^n(Z_0)}{n!}(Z-Z_0)$$ **13**

2. a) Write the Laguerre differential equations and obtain its solution by the power series method. **8**

   b) For the Bessel function $J_n(x)$ establish the following

   $$J_{1/2}(x)=\sqrt{(2/\pi)}\,x\sin x$$ **5**

3. a) Describe the orthogonal curvilinear coordinate system. **6**

   b) State and prove Stoke's theorem. **7**

PART – B

4. Define the eigen values and eigen vectors of a matrix. Find the eigen values and normalized eigen vectors of the matrix $\begin{pmatrix}5&0&2\\0&1&0\\2&0&2\end{pmatrix}$. **13**

5. a) Prove that addition and subtraction of two tensor of same order is also a tensor of same order. **6**

   b) State the quotient law for tensors. Illustrate the same with an example. **7**

P.T.O.

6. a) Define convolution of two functions. State and prove convolution theorem for Fourier transforms. 8

   b) Solve the differential equation, $Y''(t) + \omega^2 Y(t) = 0$ with boundary conditions $Y(0) = A$ and $Y'(0) = 0$ using Laplace transforms. 5

PART – C

7. Starting with D'Alembert's principle derive Lagrange's equations of motion for a conservative holonomic system. 13

8. a) Discuss the mechanics of system of particles and state the conservation law for linear and angular momentum. 8

   b) Describe different types of constraints for a mechanical system with examples. 5

9. a) Derive Hamilton's equations of motion. 8

   b) Establish that if the Lagrangian does not involve time explicitly then Hamiltonian is the total energy of the system and is a constant of motion. 5

PART – D

Solve the followings : (5×4=20)

10. a) Find the divergence of $\vec{A}(x, y, z) = xy\,\hat{i} + yz^2\,\hat{j} + zx^2\,\hat{k}$.

    b) Show that the Kronecker delta δ^i_j is a mixed tensor of rank 2.

    c) Find the Laplace transform of $g(t) = \cos(bt)$ where b is a real constant.

    d) Define Poisson brackets and list their properties.

    e) Show that $P_n(-x) = (-1)^n P_n(x)$.

DPA – 520 PHY (F)

M.Sc. Previous (Physics) Degree Examination, August/September 2008

(Freshers)

Directorate of Correspondence Course

Paper – II : QUANTUM AND STATISTICAL MECHANICS

Time : 3 Hours Max. Marks : 85

*Notes : Answer Part D. Answer **FIVE** questions from Part **A**, **B** and **C** without omitting **any** Part.*

PART – A

1. a) State the axioms of a linear vector space over a complex field. Discuss the additional axioms to be satisfied in the case of Hilbert space.

   b) Show that the eigenvalues of a Hermitian operator are real and the eigenvectors belonging to distinct eigenvalues are orthogonal. **(9+4)**

2. a) Show that if two operators A, B commute with each other and A is non-degenerate, then the eigenvectors of A are also the eigenvectors of B. Discuss the situation when both of them are degenerate.

   b) Prove the commutator identity [AB, C] = A[B, C] + [A, C]B. **(9+4)**

3. a) Describe position-momentum and time-energy uncertainty relations.

   b) Obtain the transmission co-efficient for a particle with energy $E < V_0$ subjected to a potential barrier of height V_0. **(5+8)**

PART – B

4. a) Express the position and momentum operators x and p of a particle, moving in an one-dimensional harmonic oscillator, in terms of ladder operators a and a†. Hence obtain the Hamiltonian in terms of a and a†. Explain why a and a† are called ladder operators.

P.T.O.

b) Evaluate the expectation values ⟨x⟩ in the ground state of the harmonic oscillator. **(9+4)**

5. a) Using separation of variables method, derive the radial equation for the electron bound in a hydrogen atom. Solve this equation to obtain energy eigenvalues.

   b) Find the degeneracies of ground and excited states of the electron in hydrogen atom. **(10+3)**

6. a) Describe briefly, variation method for calculating the ground state energy of a quantum mechanical system.

   b) Outline how the ground state energy of helium atom is estimated using variational method. **(4+9)**

PART – C

7. a) Explain the term 'ensemble'. What is the difference between canonical and grand canonical ensembles ?

   b) Deduce the condition for statistical equilibrium of two systems in thermal contact with each other. **(6+7)**

8. a) State and prove Boltzmann equipartition theorem for energy in a classical gas of non-interacting particles.

   b) Applying the equipartition theorem, deduce the Dulong-Petit law concerning lattice specific heats. **(8+5)**

9. a) Derive Maxwell-Boltzmann energy distribution formula for a gas of indistinguishable particles in thermal equilibrium at temperature T.

   b) Write a short note on Planck's black body radiation. **(8+5)**

PART – D

Answer the following :

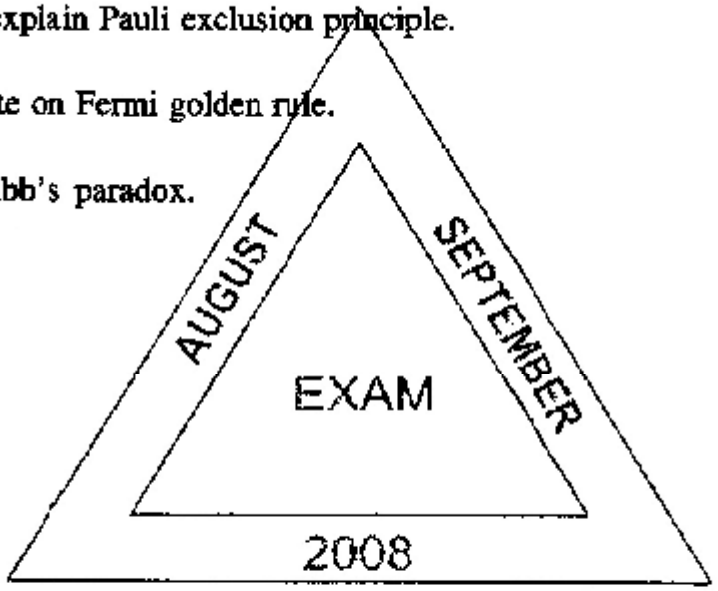
10. a) State Eherenfest's theorem. Show that $\left(\frac{d<x>}{dt}=\frac{<px>}{m}\right)$.

b) Show that the components of orbital angular momentum operator $\vec{L}=\vec{r}\times\vec{p}$ do not commute with each other. Evaluate $[L^2, L_z]$.

c) State and explain Pauli exclusion principle.

d) Write a note on Fermi golden rule.

e) Explain Gibb's paradox. **(5×4=20)**



M.Sc. Previous (Physics) Examination, August/September 2008

Directorate of Correspondence Courses

(Freshers)

Paper – III : SOLID STATE PHYSICS

Time: 3 Hours Max. Marks: 85

*Notes : Answer Part D. Answer **any FIVE** questions from Part A, B and C without omitting **any** Part.*

PART – A

1. a) What is reciprocal lattice ? Explain how it can be constructed.

   b) Describe :

      i) Rotation and

      ii) Powder photograph methods of x-ray diffraction. **(4+9)**

2. a) What are Brillouin Zones ? Construct first three Brillouin Zones for a two dimensional square lattice of side 'a'.

   b) Find structure factor for fcc lattice. **(9+4)**

3. a) Define diamagnetic susceptibility and give its theory.

   b) Calculate effective number of Bohr magnetons for Cu^{2+} ($3d^9$). **(9+4)**

PART – B

4. a) Discuss the thermodynamics of superonducting transitions.

   b) Derive the first London equation. **(9+4)**

5. a) Define :

      i) Polarizability ii) Polarization and iii) Dielectric constant

   b) Obtain Lorentz-Lorentz relation and calculate polarizability for a solid with dielectric constant 8. **(6+7)**

P.T.O.

6. a) Show that in metals electronic specific heat is proportional to its temperature.

   b) Define density of states and obtain its energy dependence. **(7+6)**

PART – C

7. a) Discuss the significance of effective mass of electron and holes.

   b) Describe the Kronig-Penny model of electrons subjected to a periodic lattice potential. **(4+9)**

8. a) Obtain an expression for the carrier density in an intrinsic semiconductor. Explain the behaviour of intrinsic conductivity with temperature.

   b) Slope of $\ln\sigma$ versus inverse temperature is 10×10^3 at 300 K, calculate energy gap. **(9+4)**

9. a) Distinguish Frenkel and Schottky defects.

   b) Obtain an expression for concentration of Frenkel defects. **(4+9)**

PART – D

10. Write explanatory note of the following: **(5×4=20)**

    a) Structure factor of NaCl.

    b) Van der Waal's type of binding.

    c) Effective mass of electrons and holes.

    d) Neutron diffraction.

    e) Bridgeman technique.

DPA – 540 PHY (F)

M.Sc. Previous (Physics) Examination, August/September 2008
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Directorate of Correspondence Course
Paper – IV : ELECTRONICS

Time : 3 Hours Max. Marks : 85

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

PART – A

1. a) State and prove the Maximum Power Transfer theorem.
   b) State and explain Norton's theorem. **(8+5=13)**

2. a) What is characteristic impedance ? Derive an expression for characteristic impedance of a transmission line.
   b) Describe advantages of active filters over passive filters. **(8+5=13)**

3. a) Discuss the behaviour of transmission line as a circuit element.
   b) What is impedance matching ? Explain. **(8+5=13)**

PART – B

4. a) Discuss in detail the characteristics of an n-channel FET.
   b) Describe a series regulator circuit. **(9+4=13)**

5. a) Explain the Universal biasing method with a diagram.
   b) Write a comparative note on CE and CB configuration of amplifiers. **(7+6=13)**

6. a) Explain the working of a monostable multivibrator with a diagram.
   b) With a diagram explain the working of a phase shift oscillator circuit. **(6+7=13)**

P.T.O.

PART – C

7. a) With a diagram explain the performance of an voltage follower circuit. What are its applications ?

   b) Explain a differentiator circuit with a diagram. **(7+6=13)**

8. a) State and explain De-Morgan's theorem.

   b) With a diagram explain the working of a J-K flip-flop. **(7+6=13)**

9. a) Explain how Op-Amp can be used as adder with relevant circuit diagram.

   b) With an example show how BCD no. can be converted to Excess – 3 codes. **(7+6=13)**

PART – D

10. Answer the following : **(5×4=20)**

    a) State Thevenin's theorem.

    b) What are conditions for pass band and stop band filters ?

    c) What are the criteria for oscillations ?

    d) What are the ideal Op-Amp characteristics ?

    e) What is CMRR and its significance ?