# Previous Year M.Sc., Degree Examinations

## September /October 2015

## Directorate of Distance Education

## PHYSICS

## DPA 510 : Paper I : Mathematical Methods and Classical Mechanics

*Time: 3 hrs]* *[Max.Marks: 75/85*

*Instructions :* *1. Answer any FIVE questions from Parts A,B and C without omitting any Part.*
*2. Part D is compulsory for those who appear with maximum marks 85.*

### PART - A

**Note : Answer any FIVE full questions.**

**1.** a) Show that the function $f(z) = \sqrt{|xy|}$ is not regular at the origin although the Cauchy – Riemann equations are satisfied at that point.

b) Prove Cauchy Integral theorem

c) Apply Calculus residues to prove that $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = \frac{2\pi}{\sqrt{3}}$ **5+5+5**

**2.** a) Prove the following orthogonal relation for Bessel's polynomials.

$\int_0^a J_n(\mu r)\, J_n(\mu' r)\, r\, dr = 0$ where $\mu$ and $\mu'$ are different roots of $J_n(\mu\, \alpha) = 0$

b) Prove that $n\, P_n(x) = (2n-1)\, x\, P_{n-1}(x) - (n-1)\, P_{n-2}(x)$ **8+7**

**3.** a) Discuss Gauss's divergence theorem.

b) Obtain Laplacian operator in spherical co-ordinate system. **8+7**

### PART - B

**4.** a) Define Hermitian matrix and unitary matrix. Show that every square matrix A can be uniquely expressed as the sum of a Hermitian and a Skew Hermitian matrix.

b) Find the inverse of the matrix $\begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 1 \end{bmatrix}$ **8+7**

***Contd…2***

**5.** a) Explain the law of transformation of second rank tensors.

b) State the quotient law for tensor. Illustrate the same with an example.

c) Obtain tensor form of Gradient. **5+5+5**

**6.** a) Apply Fourier's series. for the expansion of f(x) = x sin x in the interval $-\pi \leq x \leq \pi$ hence deduce that $\frac{\pi}{4} = \frac{1}{2} + \frac{1}{1\bullet 3} - \frac{1}{3\bullet 5} + \frac{1}{5\bullet 7}$

b) Show that Fourier transform of a Gaussian function is also Gaussian. **8+7**

## PART-C

**7.** a) Starting with D'Alemberts principle, derive Lagrange's equations of motion for a conservative holonomic system.

b) What do you mean by the constrained motion of a system of particles? Classify the different kinds of constraints giving examples for each kind. **8+7**

**8.** a) Define a central force. Show that angular momentum is a conserved quantity for a body in a central force field.

b) Discuss Rutherford scattering. **8+7**

**9.** a) Obtain the equation of motion of a particle in a central force field, obtain the orbit equation. Discuss the nature of orbits.

b) What are canonical transformations? Discuss canonical transformations in terms of the generating function F. **8+7**

## PART-D

**10. Answer any TWO of the following:** **2 X 5=10**

a) Using the generating function for Legendre polynomials, prove the recurrence relation :

$$P_{n+1}(x) - P_{n-1}(x) = (2n+1)\, P_n(x)$$

b) Find the Eigen values and Eigen vectors of $A = \begin{pmatrix} sin\theta & cos\theta \\ -\cos\theta & sin\theta \end{pmatrix}$

c) Evaluate the Poisson braket $[L_x, P_y]$

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# Previous M.Sc., Degree Examinations

## September /October 2015

## Directorate of Distance Education

## PHYSICS

## DPA 520 : Paper II : Quantum and Statistical Mechanics

*Time: 3 hrs]* *[Max.Marks: 75/85*

*Instructions :* *1. Answer any FIVE questions from Parts A,B and C without omitting any Part.*
*2. Part D is compulsory for those who appear with maximum marks 85.*

### PART - A

**1.** a) Explain in brief, linear vector space, Hilbert space, linear operator and inner product of vectors.

b) Prove that i) Eigen values of a Hermitian operator are real ii) Eigen functions of a Hermitian operator corresponding to different eigen values are orthogonal **8+7**

**2.** a) State and illustrate Ehrenfert's theorem.

b) What is the principle of superposition ? Explain its significance. **11+4**

**3.** a) Obtain the transmission coefficient (T) for a particle of energy $E < V_0$ in a finite height square potential barrier of width 2a for

$V(x) = V_0$ for $-a < x < a$

$= 0$ for $|x| > a$

What happens to T when $V_0 \rightarrow \infty$ ?

b) Write a note on quantum mechanical tunneling. **12+3**

### PART - B

**4.** a) Starting from the time independent Schrodinger equation for a one dimensional harmonic oscillator. Obtain the energy eigen values and eigen functions.

b) Show that the first order stark shift in a hydrogen atom is zero. **7+8**

***Contd…2***

**5.** a) Describe Stern-Gerlach experiment and explain its role in the development of quantum mechanics.

b) Evaluate the commutation relations i) $[L_x, L_y]$ and ii) $[L^2, L_z]$ **7+8**

**6.** a) Discuss the time dependent perturbation theory for a system of non-degenerate energy levels.

b) Using the appropriate expression for the first order coefficient $C_k^{(i)}(t)$, arrive at the Fermi golden rule. **7+8**

## PART - C

**7.** a) Derive Maxwell-Boltzmann energy distribution formula for a gas of indistinguishable particles, in thermodynamic equilibrium at temperature T.

b) List out the criterion for distinguishability and indistinguishability. **11+4**

**8.** a) What are macro and micro states of a statistical system ? Explain.

b) State and prove Liouville theorem. **7+8**

**9.** a) Explain Bose – Einstein condensation and discuss its significance.

b) Arrive at Dulong and Petit's law using equipartition theorem. **8+7**

## PART – D

**Answer any TWO of the following :**

**10.** a) Show that commuting observables with nondegenerate Eigenvalues have common set of Eigen functions.

b) What is Pauli exclusion principle ? Explain.

c) Give the statistical interpretation of entropy. **2X5=10**

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# Previous M.Sc., Degree Examinations

## September /October 2015

## Directorate of Distance Education

## PHYSICS

## DPA530 Paper – III : Solid State Physics

*Time: 3 hrs.]* *[Max.Marks:75/85*

***Instructions :*** 1. Answer any FIVE questions from Part A, B and C without omitting any Part.
2. Part D is compulsory for those who appear for paper with maximum marks 85.

### PART - A

**1.** a) What are point groups and space groups? Explain how one can deduce 32 point groups.

b) Obtain the Miller indices of a plane which intercepts at a, b/2, 3c in a simple cubic unit cell. Draw a neat diagram showing the plane **(9+6)**

**2.** a) What is a structure factor? Calculate the structure factor for NaCl and Diamond.

b) Define the reciprocal lattice for the simple cubic lattice and show that the reciprocal of a reciprocal lattice is a direct lattice. **(8+7)**

**3.** a) Discuss with examples the various crystal bindings exists in solids.

b) Give the Langevin theory of diamagnetism. **(7+8)**

### PART - B

**4.** a) What are superconductors? Give an account on the specific heat in superconducting state.

b) Give the qualitative ideas of BCS theory of superconductivity. **(8+7)**

**5.** a) Define polarization. Discuss the various microscopic polarization mechanisms in dielectrics

b) Derive the Lorentz - Lorenz relation and comment on its importance **(8+7)**

**6.** a) Discuss the failures of classical free electron theory of metals

b) Obtain an expression for thermal conductivity of metals and comment on the Wiedemann Franz law **(7+8)**

***Contd…2***

## PART - C

**7.** a) Discuss the formation of energy bands in one dimensional periodic solids following Kronig Penny model.

b) Write a note on effective mass of electrons. **(9+6)**

**8.** a) What are intrinsic semiconductors? Obtain an expression for the conductivity of an intrinsic semiconductor.

b) Obtain an equilibrium concentration for Frenkel defects. **(8+7)**

**9.** a) Describe the Czochralski method of crystal growth.

b) Discuss the Neutron diffraction technique for the crystal structure analysis**.** **(7+8)**

## PART – D

**10. Write short notes on any TWO of the following**: **(5+5)**

a) Primitive unit cell

b) Ewald's sphere

c) Hall effect

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# Previous M.Sc., Degree Examinations

## September /October 2015

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## PHYSICS

## DPA540: Paper IV – Electronics

*Time: 3 hrs.]* *[Max.Marks:75/85*

***Instructions :*** 1. Answer any FIVE questions from Part A, B and C without omitting any Part.
2. Part D is compulsory for those who appear for paper with maximum marks 85.

### PART - A

**1.** a) With the help of suitable circuit diagram, explain the mesh current and nodal method of network analysis.

b) Explain the terms : driving point impedance and transfer impedance of a multi mesh network. **10+5**

**2.** a) Define the characteristic impedance of an infinite ladder network. Obtain an expression for the characteristic impedance of $\pi$ and T sections.

b) With a suitable example, explain active filter. What are the advantages of active filters over passive filters. **8+7**

**3.** a) Obtain an expression for the characteristic impedance of a two wire transmission line. Explain the attenuation of radio frequency signals in a transmission line.

b) Obtain expressions for reflection coefficient and standing wave ratio of a transmission line. Calculate the reflection coefficient and standing wave ratio of infinite, short circuited and open circuited lines. **6+9**

### PART - B

**4.** a) Explain the construction and working of a p-n junction diode. Explain the characteristics of a Zener diode. Discuss the design of a voltage regulator circuit using such a diode.

b) Discuss in detail the characteristics of a FET. **9+6**

***Contd…2***

**5.** a) With neat circuit diagrams explain briefly the design and working principles involved in the construction of a C-E and C-C amplifier.

b) Discuss the different biasing methods employed in transistor amplifiers. **9+6**

**6.** a) Discuss the feedback requirements and criteria for oscillation in transistor oscillator. With a neat circuit diagram explain the working of a Wien Bridge oscillator,

b) Explain the principle of working of astable, monostable and bistable multivibrators. **9+6**

**PART - C**

**7.** a) Discuss the characteristics of an ideal operational amplifier. With suitable circuit diagrams explain the working of an inverting and non inverting amplifiers.

b) Explain the working principles of opamp based Wein bridge and phase shift oscillators. **9+6**

**8.** a) With reference to digital electronics, explain with examples the following terms: i) number systems and codes, ii) hexadecimal and octal, iii) BCD, grey codes and excess-3 codes,

b) Explain the working of I) adder and subtractor circuits, ii) differentiator and integrator. **10+5**

**9.** a) Explain how Karnaugh maps are employed in the simplification of a logic function. Give an example

b) Discuss the action of AND, OR, NOR, NOT, NAND and XOR logic gates with suitable truth tables. **6+9**

**PART - D**

**10. Answer any TWO of the following**:

a) Regulated power supply.

b) Flip-flop circuits

c) Thevenin's and Norton's theorem. **2 X 5 = 10**

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