**M.Sc. (Previous) DEGREE EXAMINATION, DECEMBER 2008.**

**First Year**

**Physics**

**Paper I — MATHEMATICAL PHYSICS**

**Time : Three hours** **Maximum : 100 marks**

**Answer any FIVE of the following. (5 × 20 = 100)**

**1.** (a) Starting from the Legendre's differential equation prove the orthogonal property.(12)

(b) Find the values of Bessel function $J_{+3/2}(x)$ and $J_{-3/2}(x)$. (8)

**2.** (a) Starting from generating function of Hermite polynomials prove that

$H_{n-1}(x) = 2xH_n(x) - 2n\,H_{n-1}(x)$. (10)

(b) Using Leguerre polynomials prove

$$(n+1)\,L_{n+1}(x) - (2n+1-x)\,L_n(x) - n\,L_{n-1}(x) = 0. \quad (10)$$

**3.** (a) State and prove Laurent theorem. (12)

(b) Expand $f(z) = \sin z$ in a Taylor series about $z = \pi/4$. (8)

**4.** (a) State and prove Cauchy-Riemann equations. (12)

(b) Prove that $u = e^{-x}(x\sin y - y\cos y)$ is harmonic. (8)

**5.** (a) Define outer product, inner product and contraction of tensors with given examples. (10)

(b) Show that if $A_{rs}^{pq}$ is a tensor, then $A_{rs}^{pq} + A_{sr}^{qp}$ is a symmetric tensor and $A_{rs}^{pq} - A_{sr}^{qp}$ is a skew symmetric tensor. (10)

**6.** (a) Obtain the expression for three dimensional elasticity of a crystal using tensors. (12)

(b) Show that the Kronocker delta function is a mixed tensor of rank two. (8)

**7.** (a) Solve the equation $\frac{dx^2}{dt^2} - 2\frac{dx}{dt} + x = c^t$ with $x = 2$ and $\frac{dx}{dt} = -1$ and $t = 0$ using Laplace transformation. (10)

(b) Find the Laplace transform of $\sin^3 2t$ and $t^3 e^{-3t}$. (10)

**8.** (a) Find the Fourier sine and cosine transform of $2e^{-5x} + 5e^{-2x}$. (12)

(b) Obtain the Fourier transform of Dirac delta function. (8)

**9.** Answer any TWO of the following : (2 × 10 = 20)

(a) State and prove Cauchy's integral formula

(b) Prove that $\pi\,J_n(x) = \int_0^2 \cos(n\theta - x\sin\theta)\,d\theta$ using Bessel function.

(c) Show that

$$(l+1)\,P_{l+1}(x) - (2l+1)\,xP_l(x) + lP_{l-1}(x) = 0\,.$$

(d) Mention the different types of tensors. Give the transformation laws for tensor of 3rd rank.

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**(DPHY 02)**

**M.Sc. (Previous) DEGREE EXAMINATION, DECEMBER 2008.**

**First Year**

**Physics**

**Paper II — CLASSICAL MECHANICS AND STATISTICAL MECHANICS**

**Time : Three hours** **Maximum : 100 marks**

**Answer any FIVE questions.**

**All questions carry equal marks.**

**1.** (a) Distinguish between conservative and non-conservative mechanical systems. Obtain Lagrange's equations of motion for a conservative system using D'Alembert's principle.

(b) Explain the principle of least action.

**2.** (a) What are Eulerian angles? Explain their importance.

(b) Obtain the relation between the angular momentum and kinetic energy of a rigid body.

**3.** (a) Derive the Hamilton-Jacobi partial differential equation and discuss the physical significance of the Hamilton's generating function.

(b) Explain the importance of action angle variables.

**4.** (a) Formulate the theory of small oscillations.

(b) Determine the normal modes and frequencies of vibrations of a linear triatomic molecule.

**5.** (a) What is a micro-canonical ensemble? Obtain the equipartition theorem.

(b) Explain Gibb's paradox.

**6.** (a) Explain energy fluctuations in a Canonical ensemble.

(b) Discuss the equivalence between the canonical ensemble and grand canonical ensemble.

**7.** (a) Give a brief account of the postulates of quantum statistical mechanics.

(b) Explain the third law of thermodynamics.

**8.** (a) Obtain the equation of state of an ideal Fermi gas.

(b) Explain the salient features of Bose-Einstein condensation.

**9.** Write notes on any TWO of the following :

(a) Cyclic coordinates.

(b) Lorentz transformation.

(c) Density fluctuations in grand canonical ensemble.

(d) Partition function.

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**(DPHY 03)**

**M.Sc. (Previous) DEGREE EXAMINATION, DECEMBER 2008.**

**First Year**

**Physics**

**Paper III —QUANTUM MECHANICS**

**Time : Three hours** **Maximum : 100 marks**

**Answer any FIVE questions.**

**All questions carry equal marks.**

**1.** (a) Define the terms 'eigen function' 'expectation value' and 'degenerate eigen functions' with examples.

(b) State and prove Ehernfest theorem.

**2.** (a) Discuss the motion of an electron across a potential step of finite height. Calculate the reflection and transmission coefficients.

(b) Obtain the eigen functions and eigen values for a rigid rotator.

**3.** (a) Obtain first and second order wave functions for time independent perturbation theory.

(b) Apply perturbation theory to explain stark effect in hydrogen atom.

**4.** (a) What is variation principle? Apply this principle to explain the ground state of helium atom.

(b) Explain sudden and adiabatic approximations.

**5.** (a) Prove that the operators $\hat{L}^2$ and $\hat{L}_z$ commute but $\hat{L}_x$ and $\hat{L}_y$ do not commute. Discuss the physical significance of these commutation relations.

(b) Explain spin angular momentum and obtain paulis spin matrices.

**6.** (a) What are Clebsch - Gordon coefficients? Explain their properties.

(b) State and prove Wigner - Eckart theorem.

**7.** (a) Obtain the equation of motion for an operator in Heisenberg picture and bring out the condition for a dynamical variable to be a constant of motion.

(b) Obtain Dirac's relativistic equation for a particle.

**8.** Write short notes on any TWO of the following :

(a) Bra and ket notation.

(b) WKB method.

(c) Matrices for $J^2$ and $J_x$

(d) Klein Gordon equation.

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**(DPHY 04)**

**M.Sc. (Previous) DEGREE EXAMINATION, DECEMBER 2008.**

**First Year**

**Physics**

**Paper IV — ELECTRONICS**

**Time : Three hours** **Maximum : 100 marks**

**Answer any FIVE questions.**

**All questions carry equal marks.**

**1.** (a) With a neat diagram, explain the working of a difference amplifier.

(b) Discuss the operation of a voltage follower.

**2.** (a) Draw the circuit of 555 timer and explain how different types of waves can be generated.

(b) Explain the working of class B push pull amplifier.

**3.** (a) Discuss TEM wave propagation in coaxial line resonant cavities.

(b) What is magic T? Explain its features.

**4.** (a) Draw the block diagram of superheterodyne receiver and explain its working.

(b) Give a brief account of sky wave propagation.

**5.** (a) Draw the circuits of NAND, NOR and EX-OR gates and draw their truth tables.

(b) Explain the working of multiplexer encoder with a neat circuit.

**6.** (a) Discuss the working of synchronous and asynchronous counters with neat sketches.

(b) Explain the working of D/A converters with a neat circuit.

**7.** (a) With suitable examples explain the addressing modes of 8085.

(b) Write an assembly language program to arrange an array of numbers in ascending order.

**8.** (a) Draw the block diagram of the internal architecture of 8086 and explain the function of each block.

(b) Write an assembly language program to transfer a block of data to a new location.

**9.** Write notes on any TWO of the following :

(a) Wien bridge oscillator

(b) Magnetron

(c) J-K flip flops

(d) Memory management of 8085.

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