

1. (a) State and prove orthogonal property and normalization property of Hermite Polynomials.
(b) Using the Rodrigue's formula for Hermite polynomials, evaluate $H_0(x)$, $H_1(x)$, $H_2(x)$ and $H_3(x)$.
2. (a) Obtain the solution for Bessel's function.
(b) Prove that $J_{-\frac{3}{2}}(x) = \sqrt{\frac{2}{\pi x}} \left(-\sin x - \frac{\cos x}{x} \right)$.
3. (a) State and prove Cauchy's integral formulae.
(b) Evaluate $\oint_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)^2(z-2)} dz$ if $|z|=3$.
4. (a) State and prove Laurent's theorem.
(b) Expand $f(z) = z^3 - 3z^2 + 4z - 2$ about $z = 2$ in Taylor's series.
5. (a) Explain what is meant by a Tensor with suitable example. How the tensors are classified.
(b) Show that the covariant derivative of a contravariant vector is a mixed tensor of rank two.
6. (a) If a vector has components x , y and z in Cartesian coordinates, obtain the components in polar coordinates and show that they are respectively $r \cos \theta$ and $r \sin \theta$, $(2/r)$.
(b) Obtain the tensor laws of transformation of Christoffel symbol.
7. (a) State and prove the Laplace transform of derivative and Laplace transform of a periodic function.
(b) Evaluate laplace transform of $\int_0^t \left(\frac{1 - e^{-2x}}{x} \right) dx$.
8. (a) Find the Fourier series for the periodic function defined by $f(x) = -\pi$ if $-\pi < x < 0$ and hence deduce that $f(x) = x$ if $0 < x < \pi$
$$\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \dots$$

(b) Find the Fourier transform of $f(x) = \begin{cases} x, & |x| \leq a \\ 0, & |x| > a \end{cases}$
9. Answer any TWO of the following :
(a) Orthogonal property of Bessel function.
(b) Evaluate $\int_{-\infty}^{\infty} \frac{x \sin \pi x}{x^2 + 2x + 5} dx$ using the knowledge of residue theorem.
(c) Quotient law in tensors.
(d) Evaluate $L^{-1} \left\{ \frac{6s^2 + 22s + 18}{s^3 + 6s^2 + 11s + 6} \right\}$ using partial fraction.

M.Sc. (Previous) DEGREE EXAMINATION,
DECEMBER 2007.

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) Give an account of D'Alembert's principle.
(b) What are cyclic coordinates? Explain when the system is having constant of motion.
2. (a) Explain what is meant by inertia tensor.
(b) Derive an equation for torque in case of a symmetrical top with a fixed point.
3. (a) What are the postulates of special theory of relativity? What are Lorentz transformations?
(b) Give an account on Poisson Brackets.
4. (a) Give an account on Hamilton-Jacobi equation for conservative systems.
(b) What are action-angle variables?
5. (a) Give an account on equi-partition theorem.
(b) Arrive at the interval energy of classical ideal gas.
6. (a) What is an ensemble? Distinguish between microcanonical and grandcanonical ensembles.
(b) Show that microcanonical ensemble is equivalent to a canonical ensemble.
7. Give an account on the partition function and discuss about the Darwin-Fowler method.
8. (a) What are Phonons? Derive an expression for the specific heat of a solid.
(b) What is the classical limit of the partition function?
9. Answer any TWO of the following :
 - (a) Bose-Einstein condensation.
 - (b) Gibb's Paradox.
 - (c) Canonical equations.
 - (d) Eulerian angles.

Physics
Paper III — QUANTUM MECHANICS

Time : Three hours

Maximum : 100 marks

Answer any FIVE questions.

(5 × 20 = 100)

1. (a) Explain the postulates of quantum mechanics.
(b) Deduce from the classical wave equation, Schrödinger's time independent wave equation.
2. (a) State and prove Ehrenfest's theorem.
(b) Obtain the equation of motion in operator form.
3. (a) Obtain the eigen value and eigen function of a particle on the potential well $V = 0$, $0 < x < a$ and $V = \infty$ elsewhere and hence obtain average value of P_x .
(b) The wave function of a particle in a state is $\psi = N \exp\left[\frac{-x^2}{2\alpha}\right]$, where $N = \left[\frac{1}{\pi\alpha}\right]^{1/4}$. Evaluate $(\Delta x)(\Delta P)$.
4. (a) Explain the theory time-independent perturbation theory for non-degenerate case, upto second order.
(b) What is the first order perturbation for the wave equation $\frac{d^2\psi}{dx^2} + \frac{2m}{K^2}\left[E - \frac{1}{2}Kx^2 - ax^3\right]\psi = 0$?
5. (a) Give the theory WKB approximation method.
(b) Explain sudden and adiabatic approximation.
6. (a) Obtain the orbital angular momentum in spherical polar coordinates.
(b) Obtain different commutation relations of angular momentum operator, with position operator and momentum operator.
7. (a) Obtain an expression for probability density for Klein-Gordan and Dirac wave function. Discuss their significance.
(b) With the relativistic theory of Dirac, explain the intrinsic spin of electron.
8. (a) What are Clebsch-Gordan coefficients? Obtain the Clebsch-Gordan coefficients for $J_1 = J_2 = \frac{h}{2}$.
(b) Derive $\{J_+, J_-\}$, $[J_z, J_+]$.
9. Write notes on any TWO of the following :
(a) Linear harmonic oscillator
(b) Probability and current densities
(c) Stark effect in hydrogen atom
(d) Properties of Hermitian operators.

M.Sc. (Previous) DEGREE EXAMINATION, DECEMBER 2007.

First Year

Physics

Paper IV — ELECTRONICS

Time : Three hours

Maximum : 100 marks

Answer any FIVE questions.

All questions carry equal marks.

1. (a) Draw the block diagram of a difference amplifier and obtain the expressions of its output voltage in terms of the input difference voltage and the CMRR.
(b) Explain how the CMRR can be increased by using a constant current source in the differential pair.
2. (a) Draw the circuit diagram of an RC phase shift oscillator using an op-amp.
(b) Explain how the amplitude stabilized waveforms are realized.
3. (a) Explain the principle and working of a magnetron.
(b) Explain the working of magic tee.
4. (a) Describe the distinguishing features of amplitude modulation and frequency modulation.
(b) Explain the action of a simple diode detector in the reception of an AM wave.
5. (a) State and explain Demorgan's theorems.
(b) Why are the NAND and NOR gates referred to as universal building blocks? Explain.
6. (a) What are the functions of a shift register and explain how a flip-flop can be used as a storage element.
(b) What is clocked D-latch. Sketch its circuit and briefly explain its operation.
7. (a) Describe in detail the architecture of 8085.
(b) Explain briefly the various addressing modes of 8085.
8. Give an account on the instruction set and addressing modes of 8086.
9. Answer any TWO of the following :
 - (a) LC tunable oscillators
 - (b) Superheterodyne receiver
 - (c) Skywave propagation
 - (d) Encoder and Decoder.