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M.Sc. DEGREE EXAMINATION, JUNE/JULY 2025.

First Semester

Physics

CLASSICAL MECHANICS

Time : Three hours Maximum : 70 marks

Answer ALL questions from the following.

(5 × 14 = 70)

UNIT I

1. (a) Explain D'Alembert's principle and derive Lagrange's equations of motion.

   (b) Apply the Lagrangian formulation to a compound pendulum and derive its equation of motion. (14)

Or

2. (a) What are constraints? Classify them with examples.

   (b) Derive the Lagrangian for a charged particle moving in an electromagnetic field.

   (14)

UNIT II

3. (a) Deduce Hamilton's principle from D'Alembert's principle.

   (b) What are cyclic coordinates? Explain their significance in Lagrangian mechanics.(14)

Or

4. (a) Derive Hamilton's canonical equations of motion.

   (b) Apply Hamilton's formulation to a simple pendulum. (14)

UNIT III

5. (a) Define Poisson's brackets and state their fundamental properties.

   (b) Show that the components of angular momentum satisfy the Poisson bracket relations. (14)

Or

6. (a) Derive the Hamilton-Jacobi equation of Hamilton's principal function.

(b) Apply the Hamilton-Jacobi method to a linear harmonic oscillator. (14)

UNIT IV

7. (a) Define Euler angles. Explain their physical significance.

(b) Derive Euler's equations of motion for a rigid body. (14)

Or

8. (a) What is the inertia tensor? Explain the concept of principal axes and principal moments of inertia.

(b) Describe torque-free motion of a rigid body. (14)

UNIT V

9. (a) Derive the Lorentz transformations from the postulates of special relativity.

(b) Explain the relativistic Doppler effect and derive the expression for it. (14)

Or

10. (a) Discuss the covariance of physical laws under Lorentz transformation.

(b) Explain the aberration of light from stars using relativistic concepts. (14)

M.Sc. DEGREE EXAMINATION, JUNE/JULY 2025.

First Semester

Physics

INTRODUCTORY QUANTUM MECHANICS

Time : Three hours Maximum : 70 marks

Answer ALL questions from the following.

(5 × 14 = 70)

UNIT I

1. (a) Why is classical mechanics inadequate for microscopic systems.

(b) Derive and discuss the continuity equation in quantum mechanics. (14)

Or

2. (a) Define stationary states. How are they obtained from the time-independent Schrodinger equation?

(b) Discuss the tunneling effect in a finite potential barrier. (14)

UNIT II

3. (a) Explain the concept of operators in quantum mechanics.

(b) Define projection and unitary operators with examples. (14)

Or

4. (a) What is Gram-Schmidt orthogonalization procedure? Explain with an example.

(b) Show that two observables can be simultaneously measured only if their operators commute. (14)

UNIT III

5. (a) Discuss the significance of angular momentum operators in quantum mechanics.

(b) Derive the expression for the eigenvalues of L^2 and Lz. (14)

Or

6. (a) Explain how angular momentum is represented in spherical coordinates.

(b) Obtain the eigen functions for a hydrogen atom using spherical harmonics. (14)

UNIT IV

7. (a) Explain the variation method and apply it to the ground state of helium atom.

   (b) Briefly describe the WKB approximation and its application. (14)

Or

8. (a) Derive the first-order correction to energy in non-degenerate perturbation theory.

   (b) Apply the theory to a harmonic oscillator with a small anharmonic perturbation. (14)

UNIT V

9. (a) Derive Fermi's Golden Rule for transition probabilities.

   (b) Discuss the physical meaning of Einstein's coefficients in radiation transitions. (14)

Or

10. (a) Explain time-dependent perturbation theory and derive the transition amplitude.

    (b) Write a note on the adiabatic theorem and give an example. (14)

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M.Sc. DEGREE EXAMINATION, JUNE/JULY 2025.

First Semester

Physics

MATHEMATICAL PHYSICS

Time : Three hours Maximum : 70 marks

Answer ALL questions from the following.

(5 × 14 = 70)

UNIT I

1. (a) Prove that $\int_0^\infty x^{m-1} e^{-x} dx = \Gamma(m)$ and derive the relation between Beta and Gamma functions.

(b) Derive Rodrigue's formula for Legendre polynomials and use it to find $P_2(x)$. (14)

Or

(c) Solve the Bessel differential equation using power series method to obtain the Bessel function of the first kind.

(d) State and prove the orthogonality relation of Legendre polynomials. (14)

UNIT II

2. (a) Derive the generating function for Hermite polynomials and obtain $H_3(x)$ using it.

(b) Solve the Laguerre differential equation and obtain the Laguerre polynomial $L_2(x)$. (14)

Or

(c) Prove the recurrence relations for Hermite polynomials.

(d) Prove the orthogonality condition of Laguerre polynomials. (14)

UNIT III

3. (a) Define Laplace transform. Find the Laplace transform of $f(t) = te^{2t} \sin(3t)$.

(b) Solve the differential equation using Laplace transform:

$y'' + 4y = \sin(2t),\ y(0) = 0,\ y'(0) = 1.$ (14)

Or

(c) Define Fourier series and find the Fourier coefficients of $f(x) = x$ in $(-\pi, \pi)$.

(d) Obtain the Fourier transform of $f(x) = e^{-a|x|}$. (14)

UNIT IV

4. (a) State and prove Cauchy's Integral Theorem.

(b) Expand $f(z) = \frac{1}{(z-1)(z-2)}$ in Laurent series about z = 0 and find the residue at its poles. (14)

Or

(c) State Cauchy-Riemann conditions. Determine whether $f(z) = x^2 - y^2 + i2xy$ is analytic.

(d) Evaluate $\oint_c \frac{e^z}{z^2 + \pi^2} dz$ where C encloses $z = i\pi$ in the positive direction. (14)

UNIT V

5. (a) Define contravariant and covariant tensors. Explain with suitable examples.

(b) Prove the quotient law and give an example illustrating its use. (14)

Or

(c) Define outer and inner products of tensors. Show that the contraction of a tensor reduces its rank by 2.

(d) Differentiate between symmetric and anti-symmetric tensors with examples. (14)

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M.Sc. DEGREE EXAMINATION, JUNE/JULY 2025.

First Semester

Physics

ANALOG AND DIGITAL ELECTRONICS

Time : Three hours Maximum : 70 marks

Answer ALL questions from the following.

($5 \times 14 = 70$)

UNIT I

1. (a) Explain the construction and working of a Tunnel Diode. Discuss its V-I characteristics.

   (b) Describe the working of a Silicon Controlled Rectifier (SCR) with a neat diagram. (14)

Or

   (c) What is a Photo diode? Explain its working principle and applications.

   (d) Write a detailed note on CMOS and its advantages over other logic families. (14)

UNIT II

2. (a) Explain the AC analysis of a dual-input, balanced-output differential amplifier.

   (b) Define CMRR. Derive its expression and discuss its significance in Op-Amps. (14)

Or

   (c) With a neat diagram, explain the working of an Op-Amp as an integrator.

   (d) Describe the frequency response of an Op-Amp and factors affecting it. (14)

UNIT III

3. (a) Explain the generation and demodulation of AM waves with diagrams.

   (b) Describe DSBSC modulation and explain its generation method. (14)

Or

(c) What is SSB modulation? Explain its generation and detection techniques.

(d) Write short notes on Vestigial Side Band modulation and its advantages. (14)

UNIT IV

4. (a) Simplify the Boolean expression using Karnaugh map:

$F(A, B, C, D) = \sum (0, 2, 3, 6, 7, 8, 10, 11, 12, 13)$.

(b) Explain the working of a JK Master Slave Flip-Flop with logic diagram. (14)

Or

(c) What is a multiplexer? Explain the working of an 8:1 multiplexer with truth table.

(d) Explain how a synchronous counter differs from an asynchronous counter. (14)

UNIT V

5. (a) Explain the architecture of 8085 microprocessor with a neat diagram.

(b) Write an assembly language program to add two 8-bit numbers. (14)

Or

(c) Explain the addressing modes in 8085 microprocessor with examples.

(d) Describe the architecture and features of 8051 microcontroller. (14)