

St Aloysius College (Autonomous)
Mangaluru

Semester I – P.G. Examination – M.Sc. Physics
November/December - 2023

MATHEMATICAL PHYSICS - I

Time: 3 Hours

Max. Marks: 70

PART - A

Answer all questions choosing one from each unit. (15x4=60)

UNIT - I

1. a) Verify Green's theorem in a plane for $\int (3x^2 - 8y^2) dx + (4y - 6xy) dy$, where C is the boundary of the region enclosed by $y = \sqrt{x}$ and $y = x^2$. (8)
- b) Verify Stoke's theorem for $\vec{A} = (2x - y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$, where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ and its boundary and its projection in $x - y$ plane. (7)

OR

2. a) Obtain an expression for $\vec{\nabla}\phi$ and $\vec{\nabla}\times\vec{E}$ in general curvilinear coordinates. Hence identify it explicitly in spherical polar coordinates. (9)
- b) Evaluate $\int_S x^2 dydz + y^2 dzdx + 2z(xy - x - y) dxdy$ where S is the surface of the cube, $0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq z \leq 1$. (6)

ST. ALOYSIUS COLLEGE

PG Library
MANGALORE-575 002

UNIT - II

3. a) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ (8)
- b) Show that the eigen values of a Hermitians matrix are real and eigen vectors corresponding to distinct eigen values are orthogonal to each other. (7)

OR

4. a) Prove that taking inner product of two tensors is equivalent to finding their outer product and then contracting the result of the outer product. (6)
- b) Verify Cayley Hamilton theorem for the matrix and hence find A^{-1} .

$$A = \begin{bmatrix} 4 & 3 & 1 \\ 2 & 1 & -2 \\ 1 & 2 & 1 \end{bmatrix} \quad (9)$$

UNIT - III

5. a) Find the solution of the differential equation $\frac{d^2y}{dx^2} - \frac{4dy}{dx} + 3y = x$, satisfying the initial condition $y(0) = \frac{4}{9}, y'(0) = \frac{7}{3}$ (9)
- b) Solve $\frac{\partial u(x,t)}{\partial t} = h^2 \frac{\partial^2 u(x,t)}{\partial x^2}$ where h is a constant and $u(x,0) = F(x)$, $-\infty \leq x \leq \infty$. (6)

OR

6. a) Find the solution to the Laplace equation in the spherical coordinate system. (9)
- b) Discuss the classification of second order partial differential equation. (6)

ST. ALOYSIUS COLLEGE

PG Library

MANGALORE-575 003

UNIT -IV

7. a) Obtain a relation between Beta and Gamma function. (6)
- b) Solve the differential equation $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - n^2)y = 0$ by power series method. (9)

OR

8. a) Solve the Hermite differential equation to get a series solution at any regular point. (9)
- b) If $H_n(x)$ is the Hermite polynomial, show that it satisfies the recurrence relation $2xH_n(x) - 2nH_{n-1}(x) = H_{n+1}(x)$ (6)

PART - B

Answer any TWO questions:

(2x5=10)

9. a) Prove that cylindrical coordinate system is orthogonal.
- b) Show that $\sigma_y = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$ is both Hermitian and Unitary.
- c) Obtain the solution of the following partial differential equation by the method of separation of variables.
 $2x \frac{\partial u}{\partial x} - 3y \frac{\partial u}{\partial y} = 0$ where $u = u(x, y)$.
- d) Show that Hermite polynomials satisfy the recurrence relation
 $2xH_n(x) - 2nH_{n-1}(x) = H_{n+1}(x)$

--	--	--	--	--	--

St Aloysius College (Autonomous)
Mangaluru
Semester I - P.G. Examination - M.Sc. Physics
November/December - 2023

CLASSICAL MECHANICS

Time: 3 Hours

Max. Marks: 70

PART - A

Answer all questions choosing one from each unit. (15×4=60)

UNIT - I

1. a) Derive the Lagrangian for a charged particle in an electromagnetic field. (9)
- b) Obtain the Euler-Lagrangian equation. (6)
- OR**
2. a) Sketch and discuss the phase space trajectory for a harmonic oscillator. (6)
- b) Show that total angular momentum remains conserved for a system of particles. (9)

UNIT - II

3. a) Outline the Hamilton-Jacobi theory and apply it to solve the problem of one dimensional harmonic oscillator. (9)
- b) Obtain the Hamiltonian and Hamilton's equation of motion for a simple pendulum. (6)
- OR**
4. a) Derive Hamilton's equations of motion for a system of particles. (6)
- b) State and derive the principle of least action. (9)

UNIT - III

5. a) Obtain the equations of motion and the first integrals for the motion of a particle under a central force. (9)
- b) In scattering by central force field, explain the meaning of scattering cross section, scattering angle, and impact parameters. (6)
- OR**
6. a) State and prove the Kepler's first law of planetary motion. (9)
- b) What are centre of mass and laboratory reference frames? Elaborate with relevant examples. (6)

UNIT - IV

7. a) What are Euler angles? Obtain an expression for the complete transformation of matrix. (9)

- b) Derive the expression for rotational kinetic energy of a body in terms of inertia tensor and angular velocity. (6)

OR

8. a) What do you mean by stable and unstable equilibrium? Establish the Lagrangian and deduce the Lagrange's equation of motion for small oscillations of a system about stable equilibrium. (9)
- b) Construct the Lagrangian for a linear diatomic molecule. (6)

ST.ALOYSIUS COLLEGE

PG Library
MANGALORE-575 002

PART - B

Answer any TWO questions: (2x5=10)

9. a) What are generalized coordinates? Describe the advantage of their use in the solution of mechanical problems.
- b) What is an infinitesimal contact transformation? Explain.
- c) What is a central force field? What is the meaning of bounded and unbounded motion?
- d) Write a note on moment of inertia tensor.

--	--	--	--	--	--

St Aloysius College (Autonomous)
Mangaluru
Semester I - P.G. Examination - M.Sc. Physics
November/December - 2023

CLASSICAL ELECTRODYNAMICS

Time: 3 Hours

Max. Marks: 70

PART - A

Answer all questions choosing one from each unit. (15x4=60)

UNIT - I

1. a) Obtain an expression for multipole expansion for a vector potential of a circular loop carrying current and hence prove that magnetic monopoles do not exist. (9)
- b) Calculate the potential inside a uniformly charged solid sphere of radius R and total charge 'q'. (6)

OR

2. a) Derive the expression for electric field outside a polarized dielectric material. (6)
- b) Discuss the various boundary conditions in electrostatics. (9)

UNIT - II

3. a) What are retarded potentials? Obtain the expression for the same. (9)
- b) Express Maxwell's equations in terms of scalar and vector potentials. (6)

OR

4. a) Obtain the expression for Lienard-Wiechert potentials for a moving point charge. (9)
- b) Write down the four Maxwell's equations and explain each one of them. (6)

ST.ALOYSIUS COLLEGE
 PG Library

UNIT - III MANGALORE-575 003

5. a) Obtain Fresnel's equations for electromagnetic waves incident obliquely at the boundary of a medium. (6)
- b) What are wave guides? Explain the TE and TM mode propagation in the rectangular waveguides. (9)

OR

6. a) Discuss the propagation of plane electromagnetic waves in a conducting media. (9)
- b) Explain the concept of skin depth. (6)

UNIT - IV

7. a) Express Maxwell's equations in four vector notation. (9)
- b) Explain the Lorentz transformations in Minkowski space. (6)

OR

8. a) Obtain an expression for electric field of a uniformly moving point charge using Lorentz transformation. (9)
- b) Explain the relativistic Doppler effect. (6)

PART - B

Answer any TWO questions: (2x5=10)

9. a) Solve Laplace's equation in a two dimensional Cartesian Space.
- b) Write Larmor formula and explain its significance.
- c) What is Brewster's angle? Explain.
- d) What are the general transformation rules for electromagnetic fields?

--	--	--	--	--	--	--

St Aloysius College (Autonomous)
Mangaluru
Semester I – P.G. Examination – M.Sc. Physics
November/December - 2023

ELECTRONICS

Time: 3 Hours

Max. Marks: 70

PART - A

Answer all questions choosing one from each unit. (15x4=60)

UNIT -I

1. a) What is a band pass filter? Illustrate with a circuit diagram and frequency response curve. (6)
 b) Explain any opamp Feedback amplifier. Differentiate between positive and negative feedback. (9)

OR

2. a) Explain the working of a first order Low pass Butterworth filter circuit. (9)
 b) Explain Summing, scaling and averaging amplifier. (6)

UNIT -II

ST. ALOYSIUS COLLEGE

PG Library

MANGALORE-575 002

3. a) Discuss PLL as a frequency multiplier circuit. (7)
 b) Describe how the IC 555 timer can be used as an astable multivibrator. Obtain an expression for the output signal frequency. (8)

OR

4. a) Explain the working of a Voltage Controlled Oscillator. (6)
 b) With pin configuration, block diagram, and a circuit diagram of IC 555, explain the working of a monostable multivibrator. (9)

UNIT -III

5. a) What is a gun diode? Explain its construction and working. (6)
 b) Explain class-A amplifier and derive an expression for its efficiency. (9)

OR

6. a) Draw the circuit diagram of a Class-B push-pull amplifier and explain its working. (9)
 b) What is a solar Cell? Explain how it Works? (6)

UNIT -IV

7. a) What are the applications of counter circuit? Explain the working of a 4-bit binary ripple counter. (6)
 b) What are registers? Explain Serial Shift and Parallel shift Registers with relevant circuit diagrams. (9)

OR

8. a) What are pairs, Octets and Quads? Explain procedure of solving a Boolean function using a K-map (use an example). (9)
 b) What is CCD memory? Explain. (6)

PART - B

Answer any TWO questions:

(2x5=10)

9. a) Describe how a voltage to current converter works.
 b) Illustrate how PLL can be used as a frequency multiplier?
 c) Write a note on IR Emitters.
 d) Explain a De-MUX. Where they are used?
