PH 571.1

Reg. No. | | | | | | |

# St. Aloysius College (Autonomous)
## Mangaluru
## SEMESTER I - P. G. Examination – M. Sc. Physics
## January- 2023
## MATHEMATICAL PHYSICS-I

**Time: 3 hrs.** **Max Marks: 70**

**PART-A**

**Answer all questions choosing ONE from each unit. (4x15=60)**

**UNIT-I**

1. a. State and verify Green's theorem for $\oint(xy+y^2)dx+x^2dy$, where the integral is a closed curve bound by the plane y = x and $y = x^2$. (10)
   b. Obtain the expression for volume element in general curvilinear co-ordinate system. (5)

**OR**

2 a. Express $\vec{\nabla}\Phi$ and $\vec{\nabla}\times\vec{E}$ in cylindrical coordinate system. (8)
   b. Verify Gauss divergence theorem for $\vec{A}=4xz\hat{i}-y^2\hat{j}+yz\hat{k}$ taken over a region bounded by a cube x = 0 and x = 1, y = 0 and y = 1, z = 0 and z = 1. (7)

**UNIT-II**

3. a. Find the eigen values and corresponding normalised eigen vectors of the matrix.

$$A=\begin{bmatrix}1 & \sqrt{2} & 0\\ \sqrt{2} & 0 & 0\\ 0 & 0 & 0\end{bmatrix}$$ (7)

   b. Show that eigenvalues of a Unitary operation are complex numbers of unit modulus. (5)
   c. Construct the most general Hermitian matrix of order 3. (3)

**OR**

4. a. $A_\alpha^{\beta\nu}$ and $B_\delta^\theta$ are two tensors. Show that their outer product is also a tensor. (5)
   b. Define i) contra-variant and covariant vectors ii) contraction of indices in a tensor. (5)
   c. Show that addition and subtraction of two tensors is also a tensor of same rank. (5)

**UNIT-III**

5. a. Obtain the solution of 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). (5)
   b. Obtain the general solution of following differential equation in three dimensional cylindrical coordinates $(\nabla^2+k^2)\,\psi(\rho,\varphi,z)=0$ where k is a constant. (10)

**OR**

6. a. Obtain the solution to one dimensional wave equation subject to boundary condition,u(0,t)=u(l,t)=0 and initial condition $u(x,0)=f(x)$, $u_t(x,0)=g(x)$. (12)
   b. Solve the following partial differential equation by direct integration method. $\frac{\partial^2 z}{\partial x\partial y}=\frac{y}{x}+2$ (3)

**Contd...2**

**UNIT-IV**

7. a. Solve the Bessel differential equation $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+(x^2-n^2)y=0$ by power series method. (10)

   b. Prove the orthonormality relation for Legendry polynomials

$$\int_{-1}^{+1} P_m(x)P_n(x)\,dx = \begin{cases} 0 & ; m \neq n \\ \frac{2}{(2n+1)} & ; m=n \end{cases} \quad (5)$$

**OR**

8. a. Obtain the series solution of Hermite differential equation by power series method. (10)

   b. Prove the following Laguerre recurrence relation

$$(n+1)L_{n+1}(x) = (2n+1-x)L_n(x) - L_{n-1}(x) \quad (5)$$

**PART-B**

**Answer any <u>TWO</u> questions.** **(2x5=10)**

9. a. Obtain an expression for Arc length in curvilinear coordinates.

   b. What are symmetric and anti-symmetric tensors, give an example for each.

   c. Discuss the classification of linear second order partial differential equations with examples.

   d. Show that Bessel function satisfies the relation $J_n(-x) = (-1)^n J_n(x)$.

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# St Aloysius College (Autonomous)

## Mangaluru

## SEMESTER I - P. G. Examination – M. Sc. Physics

## January- 2023

## CLASSICAL MECHANICS

**Time: 3 hrs.** **Max Marks: 70**

### PART – A

**Answer all questions choosing ONE from each unit.** **(4X15 = 60)**

### UNIT - I

1. a. For a system of particles discuss conservation of linear momentum. [7]
   b. Using the D' Alembert's principle obtain Lagrange equations of motion. [8]

**OR**

2. a. What are generalized coordinates? How does the use of generalized coordinates help in reducing the number of coordinates? [7]
   b. What is meant by varitional principle? Show that the shortest distance between two points in a plane is a straight line. [8]

### UNIT - II

3. a. Outline the Hamilton – Jacobi theory and apply it to solve the problem of one-dimensional harmonic oscillator. [10]
   b. Explain infinitesimal canonical transformation. [5]

**OR**

4. a. Derive the principle of least action, bringing out clearly the type of variation involved. [10]
   b. Obtain Hamiltonian for a simple pendulum. [5]

### UNIT - III

5. a. How does a two-body problem reduce to a one body problem? Compare the corresponding factors such as mass, distance, and center of mass in the two cases. [7]
   b. Derive the equation for orbit of a particle moving under the influence of an inverse square law central force field. [8]

**OR**

6. a. Discuss the problem of scattering of charged particles by a Coulomb field and obtain Rutherford's formula for the scattering cross-section. [9]
   b. In scattering by central force field explain the meaning of scattering cross section, scattering angle, and impact parameter. [6]

**Contd...2**

**UNIT – IV**

7. a. Establish the Lagrangian and deduce the Lagranges equation of motion for small oscillations of a system in the neighbourhood of stable equilibrium. [9]

   b. Explain (i) normal modes of vibration; (ii) normal coordinates; and (iii) normal frequencies of a system. [6]

**OR**

8. a. What are principle axes and principal moments of inertia? [8]

   b. Discuss about the torque free motion of a rigid body. [7]

**PART – B**

**Answer any TWO Questions:** **(2x5=10)**

9. a. Explain holonomic and non-holonomic constraints.

   b. Deduce the Hamiltonian function and equation of motion for a compound pendulum.

   c. Prove the virial theorem.

   d. Explain stable, unstable, and neutral equilibria on the basis of potential finctions.

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**St Aloysius College (Autonomous)**

**Mangaluru**

**SEMESTER I- PG Examination- MSc Physics**

**January- 2023**

# Classical Electrodynamics

**Time:3 hrs** **Max Marks:70**

## PART A

**Answer ONE full question from each Unit** **(4x15=60)**

### UNIT I

1. a) Write a note on Laplace & Poisson equations in Electrostatics, discussing their nature, significance & utility. (6)
   b) Show that a vector potential can be expanded as a series of multipoles. Comment on the result obtained. (9)

**OR**

2. a) Solve the 3D Laplace equation for any boundary condition of your choice & comment on the solution obtained. What assumptions are made in the process? (8)
   b) State & prove the first Uniqueness theorem. (7)

### UNIT II

3. a) Write down the Maxwell equations for source-free vacuum in differential & integral form. What is the physical meaning of each equation? (6)
   b) State & prove Poynting theorem. Explain its significance. (9)

**OR**

4. a) Arrive at Maxwell equations in potential form & hence, discuss its pros & cons. (7)
   b) Compare & contrast solutions of Maxwell equations using Coulomb & Lorenz gauge respectively. (8)

### UNIT III

5. a) Write a note on propagation of EM waves in a dielectric medium. What are the physical applications of this phenomenology? (7)
   b) Given a rectangular wave-guide, analyze the modes of propagation of EM waves. (8)

**OR**

6. a) For normal incidence, show that the sum of reflectance & transmittance is unity. (10)
   b) What are the qualitative differences in the propagation modes for a rectangular & cylindrical wave-guide? (5)

### UNIT IV

7. a) Explore connection(s) between Electrodynamics & Relativity. (5)
   b) Using the postulates of Relativity, derive Lorentz transformations. How & why are they different from Galilean transformations? (10)

**OR**

8. a) Discuss magnetism as a relativistic phenomenon. (8)
   b) What is EM field tensor? Explain in detail. (7)

## PART B

**Answer Any TWO questions** **(2x5=10)**

9. a) Briefly describe the method of images in Electrostatics.
   b) What are retarded & advanced potentials?
   c) Write a note on cavity resonance.
   d) What is the motivation for expressing Electrodynamics & Maxwell equations in tensor notation? Discuss.

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**SEMESTER I- P.G. Examination – M.Sc. Physics**

**January-** 2023

# ELECTRONICS

## PART-A

**Answer all questions choosing <u>ONE</u> from each unit (4x15=60)**

### UNIT-I

1. a) With suitable diagram explain the summing, scaling and averaging amplifiers. (9)
   b) Explain the working of an op-amp as a comparator. (6)

**OR**

2. a) With suitable circuit diagram, explain the working of an Instrumentation amplifier. Mention its application. (7)
   b) What are active filters? Describe the working of high pass and band pass filters with relevant diagrams. (8)

### UNIT-II

3. a) Using suitable diagram, explain the working principle of voltage control oscillator? Write its applications. (8)
   b) Explain triangular wave generator using op-amp. (7)

**OR**

4. a) With the help of IC 555 timer circuit explain the working of astable multivibrator. What are its applications? (7)
   b) What is Phase Locked Loop (PLL)? Explain its operation, characteristics and applications. (8)

### UNIT-III

5. a) What is solar cell? Explain the construction and working of solar cell. (5)
   b) With the circuit diagram and waveform illustrate how AC power control is achieved using Silicon controlled rectifier. (5)
   c) Write a note on IR emitters. (5)

**OR**

6. a) With necessary diagram explain the working of lock in detector. (6)
   b) What are transducers? Define active and passive transducers. Explain active transducer. (9)

### UNIT-IV

7. a) Solve the following Boolean expression by K-map and draw the logic circuit for the simplified expression: $Y = AB\bar{C} + \bar{A}\bar{B}C + \bar{A}B + A\bar{C}$ (5)
   b) Explain the action of 4 bit synchronous counter. (5)
   c) Discuss any two addressing modes in a microprocessor. (5)

**OR**

8. a) Explain the working of a multiplexer and a demultiplexer. (5)
   b) Explain the working of R-2R ladder type DAC. Derive an expression for the output voltage. (5)
   c) Explain serial in serial out shift register. (5)

## PART-B

**Answer any <u>TWO</u> questions (2x5=10)**

9. a) Explain op-amp differentiator circuit.
   b) Draw op-amp based square wave generator circuit and explain its working.
   c) A power amplifier supplies 50 W to an 8Ω speaker. Find (i) a.c. output voltage (ii) a.c. output current.
   d) What is encoder? Explain with a circuit.

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