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N – 5407

Reg. No. :

Name :

First Semester M.Sc. Degree Examination, May 2022

Physics

PH 212 — MATHEMATICAL PHYSICS

(2018 & 2019 Admission)

Time : 3 Hours

Max. Marks : 75

PART – A

Answer any **five** questions. **Each** question carries **3** marks.

- I. (a) Find constants a , b , and c such that the vector field $\vec{A} = (x + 2y + az)\hat{i} + (bx - 3y - z)\hat{j} + (4x + cy + 2z)\hat{k}$ is irrotational.
- (b) Find the principal value of $\log(-3)$.
- (c) Explain the concept of Fast Fourier transform. Discuss one application.
- (d) A radioactive material emits on an average 10 particles per minute. Calculate the probability that the material will emit at least 1 particle in a given minute.
- (e) Explain Hermitian and Unitary matrices. Give an example of each.
- (f) Write down the Legendre differential equation. Find and classify its singular points.
- (g) What is meant by contravariant and covariant vectors? Give an example for each.
- (h) What is a group? Is the set of all integers excluding 0 form a group under ordinary multiplication? Explain.

(5 × 3 = 15 Marks)

P.T.O.



PART – B

Answer **all** questions. **Each** question carries **15** marks.

- II. (A) (a) Define general orthogonal curvilinear coordinates. **3**
(b) Derive the expression for Gradient in general orthogonal curvilinear coordinates. **7**
(c) Obtain the expression for Gradient in cylindrical coordinate system. **5**

OR

- (B) (a) Evaluate $\oint \frac{\exp(2z)}{(z+1)^4} dz$ where the integral is over a closed circle in the complex plane around the point $z = -1$. **10**
(b) Derive the Cauchy - Riemann conditions for analyticity of a complex function. **5**

- III. (A) Solve the transport equation $\frac{\partial u}{\partial t} + 3\frac{\partial u}{\partial x} = 0$ with $u(x,0) = f(x)$ where $f(x)$ is an arbitrary function of x .

OR

- (B) Solve the first order differential equation $y' + 2xy = 0$ using Frobenius series method.

- IV. (A) (a) Define metric tensor and show that it is covariant in both its indices. **5**
(b) What is meant by raising and lowering of indices of a tensor? **5**
(c) Obtain metric tensor for cylindrical polar coordinate system. **5**

OR

- (B) (a) Discuss the relation between symmetry and groups. **3**
(b) What is meant by reducible and irreducible representations of a group? **5**
(c) Discuss $SO(2)$ group. **7**

(3 × 15 = 45 Marks)



PART – C

Answer any **three** questions. **Each** question carries **5** marks.

- V. (a) A coin has probability of Heads 0.7 and probability of Tails 0.3. If 5 such coins are tossed, calculate the probability of getting at least two Heads.
- (b) Find all values of $16^{1/4}$.
- (c) Solve the differential equation $y'' - 5y' + 6y = 0$ with $y(0) = 2$ and $y'(0) = 2$ using Laplace transform.
- (d) Show that the Legendre function satisfies the relation $P_5'(x) = 9P_4(x) + 5P_2(x) + P_0(x)$.
- (e) Find the equation of the straight line which fits the data points (1, 1), (2, 3), (3, 5), (4, 5) (6, 6) by the method of least-squares.
- (f) Starting from the metric tensor components $g_{i,j} = \delta_{i,j}$ for the 2D space in the Cartesian system, obtain the components of the metric tensor for the polar coordinate system. (Hint : Write down the polar basis vectors in terms of the Cartesian basis vectors making use of the relations $x = r \cos(\theta)$ and $y = r \sin(\theta)$).

(3 × 5 = 15 Marks)

