

[This question paper contains 2 printed pages.]

Sr. No. of Question Paper : 1795

Your Roll No.....

Unique Paper Code : 2222011201

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Name of the Paper: : Mathematical Physics II

Name of Course : B.Sc. Hons. (Physics) NEP: UGCF-2022

Semester : II

Duration : 2 Hrs

Maximum Marks : 60

Instructions for candidates:

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Four** questions in all.
3. Question number 1 is compulsory. Attempt any **three** questions from the rest.
4. **All** questions carry equal marks.
5. Some useful formulae are given at the end.

1. Attempt any **five** questions. All questions carry equal marks. (5×3=15)

- (a) Evaluate $\iiint_V dV$ where V is the volume of the sphere of radius 4 using spherical polar coordinates.
 - (b) Find the period of (i) $\tan nx$ and (ii) $\cos 2\pi x$
 - (c) Evaluate $\int_0^\infty x^6 e^{-2x} dx$ using beta and gamma functions.
 - (d) Evaluate $\int_{-1}^{+1} [P_2(x)]^2 dx$
 - (e) Locate and name the singularity for $x^3 y'' + 2x^2 y' + y = 0$.
 - (f) Write Parseval's identity for Fourier series.
2. (a) Find the unit vectors $\hat{e}_r, \hat{e}_\theta, \hat{e}_\phi$ for spherical coordinate system in terms of $\hat{i}, \hat{j}, \hat{k}$. Also solve for $\hat{i}, \hat{j}, \hat{k}$ in terms of $\hat{e}_r, \hat{e}_\theta, \hat{e}_\phi$. (10)
(b) Represent the vector $\vec{A} = 2y\hat{i} - z\hat{j} + 3x\hat{k}$ in terms of spherical coordinates and determine A_r, A_θ and A_ϕ . (5)
 3. (a) Represent $f(x) = x^2$ in the interval $-\pi < x < \pi$ in form of Fourier series. (10)
(b) Evaluate $\int_0^{\pi/2} \sin^4 \theta \cos^5 \theta d\theta$ using beta and gamma functions. (5)
 4. Solve $xy'' + (x-1)y' - y = 0$ around $x = 0$ by Frobenius method. (15)
 5. (a) Derive the recurrence relation $nP_n(x) = xP_n'(x) - P_{n-1}'(x)$ (7.5)
(b) Expand x^2 in series of Legendre polynomials. (7.5)

Some useful formulae:

Legendre Polynomials:

$$P_0(x) = 1, P_1(x) = x, P_2(x) = \frac{1}{2}(3x^2 - 1)$$