(i) Printed Pages: 4 Roll No. .....

(ii) Questions : 9 Sub. Code : 3709

Exam. Code : 0473

M.Sc. Physics 2nd Semester

(2042)

MATHEMATICAL PHYSICS–II

Paper : PHY-8021

Time Allowed : Three Hours] [Maximum Marks : 60

Note :— Attempt **FIVE** questions in all, including Question No. **9** (Unit V) which is compulsory and selecting **ONE** question each from Unit I–IV.

UNIT—I

1. (a) Define the following with examples :

   (i) Isomorphism and homomorphism

   (ii) Character of a representation

   (iii) Lie group. 6

   (b) Show that character is a function of classes just as representation is a function of group elements. 6

2. (a) Discuss symmetry group of a square and show that these form a group of order 8. 6

   (b) What are 3-D rotation groups ? Discuss commutators and structure constants of SO(3) group. What is its significance ? 6

UNIT—II

3. (a) Find Fourier series expansion for a square wave such that $f(x + 2m\pi) = f(x)$ defined by

$$f(x) = \begin{cases} -h & -\pi < x < 0 \\ h & 0 < x < \pi \end{cases}.$$

And hence taking $x = \omega t$, show that

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \ldots\ldots = \frac{\pi}{4}. \qquad 6$$

(b) Show that if $\phi(p)$ is the Fourier transform $\psi(x)$ then

$$\langle \hat{p} \rangle = \int_{-\infty}^{\infty} \psi^*(x) \frac{\hbar}{i} \frac{d}{dx} \psi(x)\, dx. \qquad 6$$

4. (a) Explain Gibbs phenomenon with example. 6

(b) Solve the problem of a damped 1D oscillator

$\psi''(t) + 2\psi'(t) + 5\psi(t) = 0$ with $\psi(0) = 2$

and $\psi'(0) = -4$ using Laplace transforms. 6

UNIT—III

5. (a) Determine direct product of three tensors A^i and B^k_j and C^{lm}_n and prove that it is a tensor. 6

(b) Solve the equation $\phi(x) = \lambda \int_0^{2\pi} \cos(x - t)\phi(t)\, dt$ for its

Eigen values and Eigen functions. 6

6. (a) Explain inner product of two tensors. Illustrate it with an example. 6

(b) Develop an integral equation corresponding to the differential equation

$y''(x) - y(x) = 0$. Given $y(1) = 1$, $y(-1) = 1$. 6

UNIT—IV

7. (a) Explain Binomial, Poisson and Normal distributions. State central limit theorem. 6

(b) Describe Simpson and Weddle rules of Numerical Integration. 6

8. (a) Discuss about utility of random numbers and Monte-Carlo technique. 6

(b) The position of particle was found to vary with time as following :

t(in sec)	3.0	3.5	4.0	4.5	5.0
X(t) (in m)	19.354	23.640	28.127	32.734	37.549

Find its speed at $t = 4$ sec using numerical differentiation with error h^4. 6

UNIT—V

9. (a) Define n-fold symmetry axis.

(b) If $L\{f(t)\} = g(s)$ then show that $L\{e^{at} f(t)\} = g(s - a)$.

(c) What are invariant tensors ? Give examples.

(d) Differentiate between Fredholm integral equation and Volterra integral equation.

(e) What do you mean by simulation ?

(f) Write the covariant derivation of A_t^{rs}. 6×2=12