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**NY—07—2023**

**FACULTY OF SCIENCE**

**M.Sc. (First Year) (First Semester) EXAMINATION**

**NOVEMBER/DECEMBER, 2023**

**(New/CBCS Pattern)**

**PHYSICS**

**PHY-101**

**(Mathematical Methods in Physics)**

**(Tuesday, 05-12-2023)**

**Time : 10.00 a.m. to 1.00 p.m.**

*Time—3 Hours*

*Maximum Marks—75*

*N.B. :— (i) All questions are compulsory.*

*(ii) Each question carries equal marks.*

*(iii) Use of non-programmable calculator is allowed.*

1. Define what is matrix and find the eigen values, eigen vectors and diagonal matrix of the following matrix : 15

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 3 & -1 \\ 0 & -1 & 3 \end{bmatrix}$$

P.T.O.

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Or

- (a) Find the eigen values and eigen vectors of the given matrix : 8

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$$

- (b) Describe Gram Schmidt's orthogonalization process. 7

2. Show that the generating function of Hermite polynomial is : 15

$$e^{2xt-t^2} = \sum_n \frac{H_n(x)t^n}{n!}$$

where  $\frac{H_n(x)}{n!}$  is the coefficient of  $t^n$  in the expansion of  $e^{2xt-t^2}$  and prove that :

(i)  $2xH_n(x) - H_{n+1}(x) = 2nH_{n-1}(x)$

(ii)  $2nH_{n-1}(x) = H'_n(x)$ .

Or

- (a) Obtain the Rodrigues formula of  $H_n(x)$ . 8

- (b) Show that : 7

(i)  $(n + 1) P_{n+1}(x) = (2n + 1)x P_n(x) - nP_{n-1}(x)$

(ii)  $nP_n(x) = xP'_n(x) - P'_{n-1}(x)$ .

3. Define Fourier series and find the Fourier series represented by the function : 15

$$F(x) = x, \quad 0 < x < 2\pi$$

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Or

- (a) If  $f(s)$  is the Fourier transform of  $f(x)$ , then show that : 8

$$F[f(x) \cos ax] = \frac{1}{2} [f(s+a) + f(s-a)].$$

- (b) Using Laplace transform, find the solution of initial value problem : 7

$$y'' + 25y = 10 \cos 5t$$

$$y(0) = 2 \text{ and } y'(0) = 0.$$

4. Show that if  $F(z)$  is analytic in and on the closed curve 'c' and if 'a' is any point on 'c', then : 15

$$f(a) = \frac{1}{2\pi i} \int_c \frac{f(z)}{z-a} dz \text{ and}$$

$$\text{evaluate } \int_c \frac{2z^3 + 3z + 5}{z-2} dz, \text{ where } c : |z| = 3.$$

Or

- (a) Find the value of  $\int_C (x+y)dx + x^2y dy$  : 8

(i) along  $y = x^2$  having (0, 0) and (3, 9) as end points

(ii) along  $y = 3x$  between (0, 0) and (3, 9).

- (b) Show that the function :

$$u(x, y) = 2x - 2xy$$

is harmonic and find its conjugate harmonic function. 7

P.T.O.

5. Write short notes on (any *three*) :

15

- (a) Symmetric and skew-symmetric matrix with suitable examples
- (b) Cauchy Residue theorem
- (c) Properties of Fourier transform
- (d) Rodrigues formula of  $P_n(x)$ .