M.Sc. (Physics) (NEP Pattern) Semester-I

NEP-235 / 01MSCPH3 - DSC Paper-III - Mathematical Physics

P. Pages : 2 **GUG/S/25/15136**

Time : Three Hours * 2 7 8 0 * Max. Marks : 80

Either:

1. a) Define divergence & curl of a vector and give its physical meaning. **8**

b) Using Cayley Hamilton theorem find A^{-1}, given that- **8**

$$A = \begin{bmatrix} 1 & 2 & -2 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$$

OR

e) State and prove Cayley Hamilton Theorem. **8**

f) Find the eigen values and corresponding eigen vectors for the matrix. **8**

$$A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 4 \\ 0 & 4 & 9 \end{bmatrix}$$

Either:

2. a) Find the inverse of Laplace transform of- **8**

$$\frac{s^2 - 1}{\left(s^2 + 1\right)^2}$$

b) Find Fourier sine transform of- **8**

$$f(x) = \frac{e^{-ax}}{x}$$

OR

e) Find the Fourier transform of the following- **8**

$$f(x) = \begin{cases} 1 + x/a, & -a < x < 0 \\ 1 - x/a, & 0 < x < a \\ 0, & \text{otherwise} \end{cases}$$

f) Find the Fourier series of function of period 2π defined as- **8**

$f(x) = x$ if $-\pi/2 < x < \pi/2$

$= \pi - x$ if $\pi/2 < x < 3\pi/2$

Either:

3. a) Prove that for Bessel's function. **8**

$$J_n(x)J_{n-1}(x) = (-1)^n J_n(x)$$

b) Express $f(\pi) = 4x^3 + 6x^2 + 7x - 2$ in terms of Legendre polynomial. **8**

OR

e) Show that $\frac{1}{(1-t)} \exp\left(\frac{-t \cdot x}{1-t}\right)$ is the generating function of Laguerre Polynomial. **8**

f) Prove that recurrence relation for Hermite polynomials. **8**

i) $H_n'(x) = 2nH_{n-1}(x)$

ii) $H_n'(x) = 2xH_n(x) - H_{n+1}(x)$

Either:

4. a) Explain gradient, divergence and curl of tensors. **8**

b) State and prove contraction theorem of tensors. **8**

OR

e) What are matrix tensors? Obtain the component of matrix tensor in three dimensional space in terms of spherical polar coordinates. **8**

f) Show that every tensor of second order rank can be resolved into symmetric and antisymmetric part. **8**

5. Answer all of the followings-

a) Prove that the matrix $\frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$ is unitary. **4**

b) Prove that $\frac{d}{dx}\left[x^4 J_n(n)\right]^2 = x^n J_{n-1}(x)$. **4**

c) Prove that $H_{2n}'(0) = 0$. **4**

d) State and prove contraction theorem of tensor. **4**

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