FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023
(Regular/Improvement/Supplementary)
PHYSICS
FPHY1C02 - MATHEMATICAL PHYSICS I

Time: 3 Hours   **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Define curl of a vector. When will it vanish?

2. Write Laplace's equation. Explain the significance of a source free region with an example.

3. What is diagonlisation of a matrix? Why is it needed?

4. What is a pseudo tensor. Give two examples.

5. Define a Hermitian operator. Give examples.

6. Explain orthogonality of functions. What does it signify?

7. What is Fourier transform? How do we find its inverse?

8. What is Laplace transform?

(8 x 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. What are orthogonal curvilinear coordinate systems. Obtain the expressions for gradient, divergence and curl in spherical polar coordinate system assuming the general form.

10. Explain the Frobenius series solution method of solving a second order differential equation.

11. Find an expression for generating function for Bessel function of the first kind. Explain first and second kind of Bessel functions.

12. Explain Fourier series. Give the properties of Fourier series.

(2 x 5 = 10 weightage)

(P.T.O.)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. If $\vec{A}$ is a constant vector and $\vec{r}$ is a position vector, find $\nabla(\vec{F}.\vec{r})$

14. Give two quotient rules for tensors. Why are they necessary?

15. Find the eigen values of the following matrix $\begin{pmatrix} 4 & -1 & -1 \\ -1 & 4 & -1 \\ -1 & -1 & 4 \end{pmatrix}$

16. Obtain the Rodriguez formula for Hermite polynomial.

17. Given $V_1 = \begin{bmatrix} 1 & 1 & 1 & 1 \end{bmatrix}$, $V_2 = \begin{bmatrix} 1 & 1 & -1 & -1 \end{bmatrix}$ and $V_3 = \begin{bmatrix} 0 & -1 & 2 & 1 \end{bmatrix}$. Obtain a set of orthogonal vectors using Schmidt orthogonalization procedure.

18. Expand the following function into Fourier series.
    $f(x) = 0 \quad -\pi < x < 0$
    $f(x) = x \quad 0 < x < \pi$

19. Find the Fourier transform of $e^{-|x|}$.

(4 x 3 = 12 weightage)