

**D 51453**

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Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018**

(CUCSS-PG)

Physics

PHY 1C 02—MATHEMATICAL PHYSICS-I

[2017 Syllabus Year]

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. What is Laplace's equation ? How does it explain the motion of incompressible fluids ?
2. Find the volume element  $dV$  in cylindrical and curvilinear co-ordinates.
3. Prove that an arbitrary matrix can be decomposed into the sum of a Hermitian and anti-hermitian matrices.
4. Define outer product of tensors.
5. What are the difficulties involved when a differential equation is solved by applying Frobenius method ?
6. State and explain Fuch's theorem in differential equations.
7. Define Dirac delta function. State one situation where it finds application.
8. Explain what is meant by a Neumann function. Write down the expression for the function.
9. Write the Rodrigue's formula for Legendre polynomial and deduce the value of  $P_0(x)$ .
10. State the convolution theorem for Fourier transforms.
11. Using Fourier series prove that a square wave contains many high frequency components.
12. Discuss the important properties of Fourier transforms.

(12 × 1 = 12 weightage)

**Turn over**

## Section B

Answer any **two** questions.  
Each question carries a weightage of 6.

13. Explain about cylindrical and spherical polar co-ordinates and deduce expression for unit vectors in spherical co-ordinates and show that they are orthogonal.
14. Explain the method of diagonalisation and its importance. Diagonalise the matrix

$$\begin{bmatrix} -1 & 2 & -2 \\ 1 & 2 & 1 \\ -1 & -1 & 0 \end{bmatrix}.$$

15. Obtain the series solution of Bessel differential equation using Frobenius method.
16. Obtain the orthogonality relation for Laguerre polynomials.

(2 × 6 = 12 weightage)

## Section C

Answer any **four** questions.  
Each question carries a weightage of 3.

17. Prove that velocity and acceleration are contravariant vectors and the gradient of a scalar field is a covariant vector.
18. Prove that single contraction of a tensor  $A_{lm}^{ijk}$  is a tensor of rank 3.
19. Explain Gram-Schmitz orthogonalisation process.
20. Derive the relation between beta and gamma functions. Show that  $\int_0^{\pi/2} \sqrt{\cot\theta} d\theta = \frac{1}{2} \Gamma\left(\frac{1}{4}\right) \Gamma\left(\frac{3}{4}\right)$ .
21. From the generating function of Hermite polynomials, obtain the following recurrence relations.
- (i)  $2nH_{n-1}(x) = H'_n(x)$ .
- (ii)  $H'_n(x) = 2xH_n(x) - H_{n+1}(x)$ .
22. Solve the Simple harmonic oscillator problem by applying Laplace transforms.

(4 × 3 = 12 weightage)