LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FIRST SEMESTER – **NOVEMBER 2019**

PH 1820 – MATHEMATICAL PHYSICS - I

Date: 30-10-2019 Dept. No. Max. : 100 Marks
Time: 01:00-04:00

PART – A

Answer All questions: **(10 X 2 = 20 Marks)**

1. Write down the algorithm for the Regula – Falsi method.
2. Show that the expression $y = ax^2 + bx$ is reducible to linear form.
3. Express $\frac{1+i}{1-i}$ in the form of $z = c + id$
4. Define the terms electrostatic field and complex potential.
5. List the properties of linear vector space.
6. Distinguish between a set of linearly independent and linearly dependent vectors.
7. Give an illustration of occurrence of tensor in physics.
8. Define the term covariant and contravariant vectors.
9. Show that $P_{2n+1}(0) = 0$ where P stands for Legendre polynomials.
10. Obtain the value of $\beta(1,2)$ where β stands for beta function over two indices.

PART – B

Answer any Four questions: **(4 X 7.5 = 30 Marks)**

11. Find the real value of $\sqrt{17}$ corrected to three decimal places using Newton Raphson method.
12. If $u = x^3 + 3x^2y - 3x^2y - y^3$ find v such $u + iv$ is analytic.
13. Prove that the set all solutions of the differential equation $a\frac{d^2y}{dy^2} + b\frac{dy}{dx} + cy = 0$ is a vector space.
14. Obtain the metric for a 3 - dimensional space in terms of (i) polar coordinates (ii) Cartesian coordinates.
15. Show that $J_{-n}(x) = (-1)^n J_n(x)$ where J stands for Bessel's polynomials.
16. Using Euler's method, Obtain the solution of $\frac{dy}{dx} = x - y$ with $y(0) = 1$ at $x = 0\ (0.1)\ 0.4$.

PART – C

Answer any Four questions: (4 X 12.5 = 50 Marks)

17. Apply Gauss- Seidel method to solve $5x + 2y + z = 12$, $x + 4y + 2z = 15$, $x + 2y + 5z = 20$ correct upto decimal places.

18. Expand $f(z) = \frac{z-1}{z+1}$ as a Taylor's series

   a) About the point $z = 0$.

   b) About the point $z = 1$ determine the region of convergence in each case.

19. a) Determine the eigenvalues and the normalized eigen vectors of the matrix $A = \begin{pmatrix} 1 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 1 \end{pmatrix}$ and the algebraic and the geometric multiplicities.

   b) If $\lambda_1 (i = 1,2,3)$ are the eigenvalues of the matrix $B = \begin{pmatrix} 1 & 0 & -2 \\ -3 & 4 & 1 \\ 2 & 1 & 3 \end{pmatrix}$ then determine $\sum \lambda_i^3$

20. What is a fully antisymmetric tensor? Express (a) the vector product of two vectors (b) the commutation relation between the components of angular momentum in quantum mechanics by using the fully antisymmetric tensor of rank three.

21. Define Euler's first and second integrals. From first principles derive $\Gamma\left(\frac{1}{2}\right) = (\pi)^{1/2}$.

22. Solve the Legendre differential equation $(1 - x)^2 \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + n(n + 1)y = 0$ by the power series method.

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