 LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

**M.Sc.** DEGREE EXAMINATION - **PHYSICS**

FIRST SEMESTER – **NOVEMBER 2012**

# PH 1820 - MATHEMATICAL PHYSICS - I

Date : 09/11/2012 Dept. No. Max. : 100 Marks

Time : 1:00 - 4:00

**PART – A**

**Answer ALL questions: (10x2=20)**

1. Write down the formula for the Euler modified method for solution of ordinary differential equation.
2. Explain the underlying difference between Newton-Raphson method and the Regula Falsi method of solving nonlinear equations
3. Integrate Re z from 1+i to 3+2i along the straight line path.
4. Find the singular points and the corresponding residues of the complex function f (Z) = .
5. List the properties of scalar or inner product of two vectors in a linear vector space .
6. Write down the matrix representations of the orthonormal basis vectors in 3-dimensional real space and the associated projection operators .
7. Write down the transformation equations and its inverse in the Cartesian coordinates x,y,z and the spherical polar coordinates r,θ, φ.
8. What is meant by contraction of a tensor?
9. Use Rodrigue’s formula for the Legendre polynomial to evaluate the 3rd order polynomial.
10. Write down the generating function for the Bessel functions.

**PART – B**

Answer any **FOUR** questions (4x7.5=30)

1. Solve the system of linear equations x + 2y + z = 3; 2 x + y + 3 z = 8; and 3 x + y + 2 z= 7 by Gauss elimination method with pivoting .
2. (a) Integrate f(z) = counterclockwise around the circle C :|z -i| = . (3.5)

(b) Find the Maclaurin series of f(z) = tan–1z, given that = . (4)

1. (a) Prove that the eigenvalues of a Hermitian matrix are real and any two eigenvectors belonging to distinct eigenvalues are orthogonal to each other. (3.5)

(b) Prove that the eigenvalues of an anti-Hermitain matrix are either zero or pure imaginary and any two eigenvectors belonging to distinct eigenvalues are orthogonal to each other. (4)

1. (a) If a contravariant tensor of rank two is symmetric in one coordinate system, show that it is symmetric in any coordinate system. (3.5)

(b) Show that in a cartesian coordinate system, the contravariant and the covariant components of a vector are identical. (4)

1. Show that the beta function B(x,y) is related to the gamma functions by B(x,y) = and establish that B( x+1,y) = B( x,y) .

**PART – C**

Answer any **FOUR** questions (4x12.5=50)

1. Apply Newton- Raphson method to find an approximate solution of the equation ex – 3x = 0 correct upto three significsnt figures( Assume x = 0.4 as an approximate root of the equation). Verify your result by Regula Falsi method .
2. (a) Using the contour integration, evaluate the following real integral: (6.5)

(b) Evaluate the contour integral, with the contour C being (i) |z+i | = 1, and   
(ii) |z -i | = 1, counterclockwise. (3+3)

1. (a) Explain the Schmidt orthogonalisation procedure. (8)

(b) Construct an orthonormal set of three vectors from the given set of vectors = ;

; c . (4.5)

1. (a) Obtain an expression for the fractional increase in volume (dilation) associated with a deformation in terms of strain tensors. (6.5)

(b) Obtain the relation between the angular momentum and the angular velocity of a system of particles in terms of the moment of inertia tensor. (6)

1. Establish the orthonormality relation where Pn(x) is the Legendre polynomial of order n.