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DF-1520

M. Sc. (Sem. III) Examination

March / April – 2016

Physics : PH(T) - 534

(Computational & Simulation Methods In Physics)

Time : **3** Hours] [Total Marks : **70**

Instruction :

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **M. SC. (SEM. III)**

Name of the Subject :

☛ **PHYSICS : PH(T) - 534**

☛Subject Code No. : **1 5 2 0** ☛Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) Attempt all four questions.
(3) Symbols used have their usual meaning.
(4) Figures to the right indicate marks.
(5) Non-programmable scientific calculator may be used.

1 Attempt any two questions.

(i) (a) Explain how Gauss elimination method can be implemented through LU decomposition method. 3

(b) Fit the data points given below using cubic spline and determine the value of the function at x= 7 4

Xi	4	9	16
F_i	2	3	4

(ii) (a) What is the difference between polynomial interpolation, least-square fit, and spline interpolation? 3

(b) Find the Cholesky decomposition of the matrix $\begin{bmatrix} 4 & 1 & 1 \\ 1 & 5 & 2 \\ 1 & 2 & 3 \end{bmatrix}$ 4

(iii) (a) Describe essential features of cubic spline fit. 3

(b) Fit a straight line to the following set of data: 4

x	1	2	3	4	5
y	3	4	5	6	8

2 **Attempt any two questions.**

(i) (a) Explain the concepts employed in Gauss quadrature. 3

(b) For the tabular values 4

x	1.0	1.2	1.4	1.6	1.8
$f(x)$	1.543	1.811	2.151	2.577	3.107

find $O(h^4)$ value of $\int_1^{1.8} f(x)dx$ using Romberg's integration method, starting with the $O(h^2)$ values obtained using Trapezoidal rule calculations with $h = 0.4$ and $h = 0.2$.

(ii) (a) Explain the essential improvement of the Romberg method over the Trapezoidal method for numerical integration. 3

(b) Compute $\int_{-1}^{1} e^x dx$ using two point Gauss quadrature method. 4

(iii) (a) What is meant by improper integrals? How are they evaluated? 3

(b) Find the largest eigenvalue and corresponding eigenvector of the matrix $\begin{bmatrix} 1 & -3 & 2 \\ 4 & 4 & -1 \\ 6 & 3 & 5 \end{bmatrix}$ by Power method upto four iterations. 4

3 **Attempt any two questions.**

(i) (a) Develop FFT for the case, when N is the product of two integers, t_1 and t_2. 3

(b) Derive the finite difference formula corresponds to the Poisson equation in two dimensions. 4

(ii) (a) Describe Sande-Tukey algorithm for FFT. 3

(b) Establish the heat conduction equation and discuss an explicit finite difference method for its solution. 4

(iii) (a) Explain the advantage of the Fast Fourier Transforms over the Discrete Fourier Transforms. 3

(b) Use the explicit method to find the temperature distribution at t=0.1 s. and 0.2 s. of a long, thin rod with a length of 10 cm and the following values: k =0.49 cal/(s.cm.^{0}C), Δx= 2 cm, and Δt=0.1 s. At t=0, the temperature of the rod is zero and the boundary conditions are fixed for all times at T(0)=100 ^{0}C and T(10) =50 ^{0}C. The rod is of Aluminium with C= 0.2174 cal/(g.^{0}C) and ρ=2.7 g/cm^3, k=0.835 cm^2/s and λ=0.020875. 4

4 Attempt any two questions.

(i) (a) Find out acceleration formula when an object is tied on the end of a spring. Using this acceleration formula write an algorithm for motion of an object on a spring. 3

(b) Apply Kirchhoff's loop rule to a LR circuit and write an algorithm to determine current i(t) in the loop. 4

(ii) (a) Discuss the problem and a simulation algorithm of a realistic car moving in one-dimension with air resistance and rolling friction 3

(b) Write an algorithm for finding the horizontal range of a projectile fired with an initial velocity v_0 at an angle θ with the horizontal. Neglect air-resistance. 4

(iii) (a) Write an algorithm to simulate the motion of a simple pendulum with damping. 3

(b) Apply Kirchhoff's loop rule to a RC circuit and write an algorithm to determine current i(t) in the loop. 4

5 Attempt any two questions.

(i) (a) Discuss the Verlet algorithm for solution of 2^{nd} order differential equations. 2

(b) Discuss the Euler-Cromer algorithm for finding energy eigen values and eigen functions for a particle in a one-dimensional harmonic oscillator potential using time-independent Schrödinger equation 5

(ii) (a) What is Lennard-Jones interaction potential used in the molecular dynamics method for simulation of classical many particle systems? 2

(b) Write a FORTRAN subprogram to evaluate temperature of a classical gas in *Molecular Dynamics* simulation after equilibrium has been reached. 5

(iii) Discuss a mathematical model of radioactivity and a simulation algorithm for the same. 7