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Total No. of Questions : 11

M.Sc (Physics) PIT (2015 to 2017) (Sem.-2)

COMPUTATIONAL PHYSICS

Subject Code : PHS-424

Paper ID : [51116]

Time : 3 Hrs. Max. Marks : 70

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains SEVEN questions carrying FIVE marks each and students have to attempt any SIX questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Answer briefly :

a. What are logical operators in MATLAB? Give Examples.

b. What is a transcendental equation? Give one example of transcendental equation which has infinite roots.

c. There are three variables X, Y and Z in a MATLAB-program. Using the IF-ELSE construct, write the statements to find the largest among the three.

d. What are the basic differences between False position method and Secant Method" of finding the real roots of a non-linear equation?

e. What are the limitations of Gauss-elimination method of solving a system of linear equations?

f. How the uses of array ease the programming in MATLAB?

g. What are the characteristics of a good random number generator?

h. What is a loop structure in MATLAB? Give example.

i. Given a set of n-data points, how do you decide what order of polynomial to be fitted to the data? Is a higher order polynomial always better? Explain.

j. Write a piece of code in MATLAB that finds the triplets of positive integers (i,j,k) that satisfy the rule $i^2 + j^2 = k^2$.

SECTION-B

2. What are the functions in MATLAB? With suitable examples, explain how do they help in programming.

3. Explain the method of least square curve fitting and write down the expressions for the slope (m) and the intercept (c) of the straight line $y - mx + c$ fitted to a set of n data points (x,y).

4. Use the Newton's forward difference formula to numerically calculate, calculate the value of $y = f(x)$ at $x = 1.748$ from the following table :

x	1.73	1.74	1.75	1.76	1.77
$y=f(x)$	1.773	1.155	1.738	1.721	1.703

5. The Kepler's equation, $E = M + e \sin(E)$ relates the eccentric anomaly E, the mean anomaly M and the eccentricity e in an elliptical orbit, here E and M are between 0 and 2π, and e is between 0 and 1. Write a complete MATLAB-program that solves the Kepler's equation for E, using the Newton-Raphson method for a given value of e and M taken as input.

6. Explain the Monte-Carlo integration method for evaluating a definite integral of the form $I = \int_a^b f(x)dx$

7. Solve the following differential equation $\frac{dy}{dx} = \frac{x^3 + xy^2}{e^x}; y(0) = 1$ using Euler method and find $y(0.6)$ with h=0.2.

8. Explain the Linear Congruence Method for generating a sequence of pseudo-random numbers.

SECTION-C

9. a) Explain how the Monte Carlo method can be used to simulate the phenomenon of radioactive decay in a radioactive material.

   b) Explain a situation when you would prefer Monte-Carlo integration method over other numerical integration methods such as Trapezoidal method or Simpson's methods.

10. a) Derive the Simpson's l/3rd rule for numerical integration for a real function $f(x)$, defined between $[a, b]$.

    b) Showing detail numerical steps, calculate the integral $I = \int_0^1 e^{4x} dx$ using the Simpson's 1 /3rd rule by taking h=0.25.

11. Discuss the Gauss elimination method of solving simultaneous linear set of equations? Use the process of pivoting to solve the following set of equations.

    $x + 2y + 3z = 14$

    $3x - 5y + 11z = 26$

    $5x + 6y - 3z = 8$