Name: **Enrolment No:**	

UPES
End Semester Examination, December 2024

Course: Introduction to Computational Physics **Semester : VII**
Program: Integrated (B.Sc) - (M.Sc) Physics **Time : 03 hrs.**
Course Code: PHYS4003 **Max. Marks: 100**

Instructions:
1. **All questions are compulsory.**
2. **Question 7 in section B has an internal choice.**
3. **Question 10 in section C has an internal choice.**
4. **Use of scientific calculator is allowed.**
5. **Number of Pages: 3.**

SECTION A
(5 Q x 4 Marks = 20 Marks)

S. No.		Marks	CO
1	Define LaTeX and differentiate it from other typesetting formats, such as MS Word and Open Office.	**4**	**CO1**
2	Discuss the importance of algorithms and flowcharts in the process of developing computer programs.	**4**	**CO1**
3	Write a gnuplot script to save a figure in JPEG format.	**4**	**CO3**
4	Demonstrate how to plot data from a text file with column-based data using gnuplot, including the necessary code.	**4**	**CO3**
5	Define LaTeX environments for typesetting mathematical symbols. Write a LaTeX code snippet to display the equation for gravitational force $F = \frac{G \cdot m_1 \cdot m_2}{r^2}$ with appropriate formatting. Where the symbols have their usual meaning.	**4**	**CO1**

SECTION B
(4 Q x 10 Marks = 40 Marks)

6	Using Euler's Method for the equation, $\frac{dy}{dx} = y - x$, where $y(0) = 0$ calculate $y(0.2)$, $y(0.4)$ and $y(0.6)$ to four decimal places.	**10**	**CO4**
7	Describe how numerical differentiation can be used to approximate the derivative of a function. Given $f(x) = x^2$, Use the forward difference formula to approximate $f'(1)$ with $h = 0.1$. Show your calculations and discuss the impact of step size h on the accuracy of the result. ***OR*** Using the Trapezoidal Rule, approximate the integral of $f(x) = x^3 + 2x$ over the interval [1,3] with 4 equal subintervals. Show each calculation step and explain how the Trapezoidal Rule approximates the area under the curve.	**10**	**CO4**
8	What are the components of a LaTeX document preamble? Write a sample preamble for a physics lab report.	**10**	**CO1**
9	Explain the Bisection Method for finding polynomial roots and discuss how to estimate error in the calculated roots.	**10**	**CO4**
	SECTION-C **(2 Q x 20 Marks = 40 Marks)**		
10	Describe the Runge-Kutta Method for solving ordinary differential equations (ODEs). Using the RK-4 Method, solve $\frac{dy}{dx} = 1 + y^2$, with the initial condition $y(0) = 0$, to find $y(0.2)$, $y(0.4), and\ y(0.6)$. ***OR*** Using Lagrange Interpolation, find the approximate value of $f(x)\ at\ x =$ 1.5 given the following data points: $(x_0, f(x_0)) = (1,1), \quad (x_1, f(x_1)) = (2,4), \quad (x_2, f(x_2)) = (3,9)$ Show the steps of the Lagrange formula and calculate the interpolated value.	**20**	**CO4**
11	Describe the Secant Method for finding the roots of a polynomial. Compare it with the Newton-Raphson Method, highlighting their	**20**	**CO4**

	advantages and disadvantages. Find the root of the equation $2x^2 - 9x - 9 = 0$ up to three decimal places using the Secant Method.		