Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

Course: Introduction to Computational Physics **Semester: I**
Program: M. Sc. Physics

Time 03 hrs.
Course Code: PHYS 7028 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 4 Marks (5×4 = 20 Marks)**
2. **Instruction: Attempt all questions**

S. No.	Question	CO
Q1	In "vi" editor, if you launch a command chmod 744 <filename>, how will the permissions of the file change?	**CO1**
Q2	Differentiate between static and dynamic array. Discuss briefly how dynamic arrays are created?	**CO2**
Q3	Write a Gnuplot script to implement linear regression with the data given in the file "file.txt".	**CO3**
Q4	Write a sample Latex script to prepare a table as given below:	**CO1**
Q5	Write following equations in LaTeX: (a) $c_s = kc_0(1-f_s)^{k-1}$ (b) $\left(\frac{dT_m}{dz}\right)_i = \frac{dT}{dc}\left(\frac{dc}{dz}\right)_i = -m_l\frac{v_i c_i^l}{D_l}(1-k)$ (c) $\Omega = Iv(Pe) = e^{Pe}Pe\int_{Pe}^{\infty}\frac{e^{-z}}{z}dz$ (d) $\lambda_1 = \frac{4.3}{\sqrt{\nabla T}}\sqrt[4]{\frac{D_l\Gamma\, c_0 m_l(k-1)}{kv_i}}$	**CO1**

Name	Age	Weight	Education
Mohan	24	56.6	BSc
Shyam	28	60.4	MSc
Ram	30	82.1	BTech

SECTION B

1. **Each question will carry 10 marks (10×4 = 40 Marks)**
2. **Instruction: Attempt all the questions**

Q6	A particle of mass m moving through a fluid is subjected to a viscous resistance R, which is a function of the velocity v. The relationship between the resistance R, velocity v , and time t is given by the equation: $$t = \int_{v(t_0)}^{v(t)} \frac{m}{R(u)}du$$ Suppose $R(v) = -v\sqrt{v}$ for a particular fluid, where R is in Newtons and v is in m/s. If $m = 10$ kg, $v(t_0) = 10$ m/s (initial velocity), approximate the time required for the particle to slow down to $v(t) = 5$ m/s.	**CO4**

Q7	Suppose you are given some data, the graph of which is not smooth. Can you do something to make the data smooth using Gnuplot? If yes, what are various options available? Explain this by considering a data file named "smooth.txt".	**CO3**
Q8	Apply Forward Euler method to numerically solve the following ODE: $\frac{dy}{dt} = y - t^2 + 1 \qquad 0 \le t \le 2 \qquad y(t=0) = 0.5$ Write the pseudocode for the above problem.	**CO4**
Q9	Write Latex script to write the following document. Assign equations number to the equations. **Diffusion in Binary Alloys** While deriving atomic mobility in Cahn's diffusion model, Martin proposed a method to derive the flux of species in an isotropic solid via direct exchange mechanism. We will adopt a similar scheme, but here the diffusion of the atomic species is mediated by defects (and vice versa). Contrary to Martin's atomistic description of diffusion on discrete lattice, our diffusion model is based on continuum description. We consider two parallel atomic planes at $x + d/2$ and $x - d/2$, separated by a distance d. Let us consider that n is the lattice site density of the material. For a successful jump from one plane to the other, the presence of two species is required: i and j, where i may be a material component and j may be a defect, or vice versa. The site fractions of both the species on plane 1 are $C_i(x - d/2)$ and $C_j(x - d/2)$, and on the plane 2 are $C_i(x + d/2)$ and $C_j(x + d/2)$, respectively. The number of i^{th} species per unit area at the plane 1 and 2 are $ndC_i(x - d/2)$ and $ndC_i(x + d/2)$, respectively. The flux of i^{th} species may therefore be written as $J_i = J_i^{\text{forward}} - J_i^{\text{backward}}$ $= ndC_i(x - d/2)\Gamma_{12} - ndC_i(x + d/2)\Gamma_{21},$ where $\Gamma_{12} = \eta_2 Z_2 C_j(x + d/2)\nu^{12}$ and $\Gamma_{21} = \eta_1 Z_1 C_j(x - d/2)\nu^{21}$ are forward and backward jump rates, respectively, and η_1 and η_2 are numerical factors	**CO1**

Section C

1. **Each Question carries 20 Marks (20×2 = 40 Marks).**
2. **Instruction: Q10 is compulsory. There is an internal choice for Q11**

Q10	**(a)** What do you mean by interpolation? Using the nodes (or points) $x_0 = 0, x_1 = 0.6,$ and $x_2 = 0.9$, construct Lagrange Polynomials of degree two. With the help of the Lagrange's interpolating polynomials, approximate $f(0.45)$, where $f(x) = \cos x$. **(b)** Cite important differences between direct and iterative methods of solving a system of linear equations. Use Gauss Elimination method to solve the following system of linear equations:	**CO4**

	$10x_1 + 5x_2 = 6$ $5x_1 + 10x_2 - 4x_3 = 25$ $-4x_2 + 8x_3 - x_4 = -11$ $-x_3 + 5x_4 = -11$	
Q11	a) The Saint Xavier's School Performing Arts Center auditorium contains 25 rows (numbered 1 through 25) with 50 seats each (numbered 1 through 50). Write a program in FORTRAN 90/C++ that allows a user to continuously enter a row and seat request until a sentinel value (9999) is entered (sentinel value is used to terminate a process). If the row or seat number is too high (other than 9999), issue an error message. Otherwise, determine whether the seat has already been reserved. If so, display an error message; if not, then charge the user $8.50 for a ticket and display a running total of the user's purchase. When the user enters a sentinel, display the number of seats taken and the number still available in the auditorium. (**15 Marks**) b) Write a program in FORTRAN 90/C++ that accepts your first name into a character array. Print your name backward. For example, if your name is Ram, display maR. (**5 Marks**) **OR** a) TheTonsBridge School is holding a fundraiser. The freshmen (1), sophomores (2), juniors (3), and seniors (4) hold a competition to see which class contributes the most money. Write a program in FORTRAN 90/C++ that allows you to enter two numbers for each contribution as it comes in—the class of the contributor (1, 2, 3, or 4), and the amount contributed in dollars. For example, perhaps a junior contributes $25. The user would enter a 3 and a 25. The program continues to accept data until the user types 999 for the contributor's class. At that point, data entry is completed, so display the four class totals as well as the number of the class (1, 2, 3, or 4) that contributed the most. (**15 Marks**) b) Write a program that allows the user to enter seven float values representing store sales for each day of one week. After all seven values are entered, print them to the screen, and display their sum. (**5 Marks**)	**CO2**