Name: Enrolment No:	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2023

Course: Computational methods in petroleum engineering **Semester: VII**
Program: B. Tech. (APE Upstream) **Time** : 03 hrs.
Course Code: PEAU 4021P **Max. Marks:** 100

Instructions:

(a) Use of scientific calculator is allowed for calculations. Before use, please make sure that it is approved by the invigilator.
(b) Possession of mobile or any communication device is strictly prohibited during the exam.

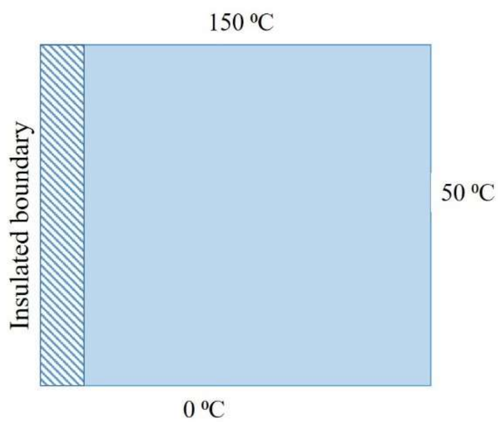
SECTION A (5Q x 4M = 20Marks)

S. No.	Statements of the questions	Marks	CO
Q 1	State the difference between regression and interpolation techniques.	**4**	**CO1 [2] CO2[2]**
Q 2	Write the full expression of 3rd order Newton's interpolating polynomial.	**4**	**CO1**
Q 3	Write the full expression of 4rd order Taylor series and the expression for the reminder terms.	**4**	**CO1**
Q 4	Write a general python code for Lagrange interpolation (*not using in-built methods*)	**4**	**CO3**
Q 5	Write any two points each to differentiate between a initial vale problem and boundary value problems?	**4**	**CO1 [2] CO2 [2]**

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

S. No.	Statements of the questions	Marks	CO
Q 6	Numerically integrate the following using **(i)** trapezoidal method with step size of 2, and **(ii)** Simpson's 1/3 rule with a step size of 1: $$\int_0^6 x^2 e^x dx$$ **OR** Use the appropriate order of Newton's interpolation technique to find the value of $f(x)$ at $x = 2$, from the following data given below. Also find the error percentage associated with the solution obtain by you. The true solution is found to be **0.69314**. Provide the necessary reason and conditions, wherever necessary.	**10**	**CO2[4] CO3[4] CO4[2]**

	<table><tr><th>x</th><th>$f(x)$</th></tr><tr><td>1</td><td>0</td></tr><tr><td>3</td><td>1.09861</td></tr><tr><td>5</td><td>1.6094</td></tr><tr><td>7</td><td>1.9459</td></tr></table>		
Q 7	Determine the roots of the function, $f(x) = e^{-x} - x$, using an open method to locate the roots. Employ an **initial guess** of your choice with proper reasoning and make **3** iterations and calculate the approximate error, ε_a for each iteration. Also find the true percentage error if the true value is 0.56714329	**10**	**CO2[4]** **CO3[4]** **CO4[2]**
Q 8	Using Runge-Kutta method to solve the following differential equation, $$\frac{dy}{dt} = -2y + t^2$$ From $t = 0$ to $t = 2$, with a step size (h) of **1**. The initial condition of $y(0) = 1$ is given. **OR** Write a general python code to solve the same differential equation as above using the same method. Write a code to check the accuracy of your obtained solution using the in-built methods available in python modules.	**10**	**CO2[4]** **CO3[4]** **CO4[2]**
Q 9	Obtain the temperature distribution of a long, thin rod by solving the partial differential with a length of 10 cm, from times, $t = 0$ s to $t = 3$ s. The material properties are given as in **Question No. 10** . Use a step size of $\Delta x = 2$ cm, and $\Delta t = 1$ s. At $t = 0$, the temperature of the rod was 5 ^{o}C and the boundary conditions are fixed for all times at $T(0) = 200$ ^{o}C and T(10) = 100 ^{o}C. $$k\frac{\partial^2 T}{\partial x^2} = \frac{\partial T}{\partial t}$$	**10**	**CO2[4]** **CO3[4]** **CO4[2]**
SECTION-C (2Q x 20M = 40 Marks)			
Q 10	(a) Use Liebmann's method to obtain the temperature distribution of the square heated plate (Fig. 1). Use a relaxation factor of **1.2**. The dimensions of the plate is **8 cm** × **8 cm**. Use at-least two interior nodes in both horizontal and vertical directions. Note that the material is	**15 + 5**	**CO2[5]** **CO3[10]** **CO4[5]**

	aluminum with specific heat, $C = 0.2174$ cal/(g · ºC) and density, $\rho = 2.7$ g/cm^3. The thermal conductivity, $k' = 0.49$ cal/(s · cm · ºC), $$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$$  (b) How can you make improvements in the accuracy of the solution obtained by you ?		
Q 11	(a) Write a python code to solve the set of simultaneous equations as below, using **LU decomposition** method with partial pivoting. (b) Write a code to check the accuracy of your obtained solution using the in-built methods available in python modules. **OR** (a) Use **Gauss-Jordan method** to solve the following simultaneous linear equations: $$3x_1 + 4x_2 + x_3 = 26$$ $$x_1 + 2x_2 + 6x_3 = 22$$ $$6x_1 - x_2 - x_3 = 19$$ Detailed steps should be provided. (b) How can you check the accuracy of solutions obtained by you?	**20**	**CO2[5]** **CO3[10]** **CO4[5]**