BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID-SEMESTER EXAMINATION SP/2024)

CLASS: B.TECH **SEMESTER:** VI
BRANCH: CHEMICAL ENGINEERING **SESSION:** SP/2024

SUBJECT: CL371 COMPUTATIONAL FLUID DYNAMICS

TIME: 02 Hours **FULL MARKS:** 25

INSTRUCTIONS:
1. The question paper contains 4 questions and a total of 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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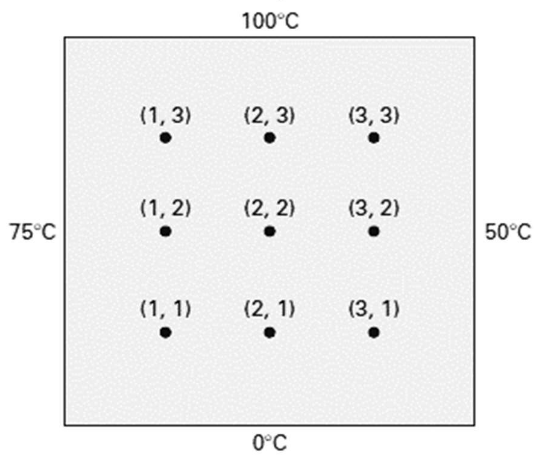
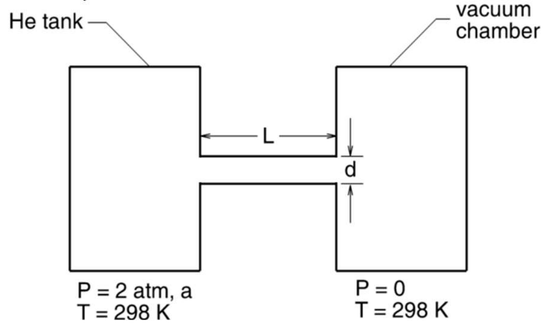
			CO	BL
Q.1(a)	What is the physical significance of the Lagrangian derivate operator $\left(\frac{D}{Dt}\right)$	[2]	1	1
Q.1(b)	Show that for any quantity $\emptyset$: $$\frac{D\emptyset}{Dt} = \vec{v}.\nabla\emptyset + \frac{\partial\emptyset}{\partial t}$$	[3]	1	3
Q.2(a)	Show that the final discretized form of the Laplace Equation ($\nabla^2 T = 0$) can be expressed as: $$4T_{i,j} - T_{i-1,j} - T_{i,j-1} - T_{i+1,j} - T_{i,j+1} = 0$$ Assume the central difference scheme of discretization with $\Delta x = \Delta y$	[3]	2	3
Q.2(b)	A two-dimensional rectangular plate is subjected to uniform temperature boundary conditions. As shown in the figure below.	[4.5]	2	3



Develop 9 linear algebraic equations for the internal nodes using the discretized equation above.

Q.2(c)	Write the final set of equation in the form of $[A][T] = [B]$	[2.5]	2	3
Q.3	Determine the boundary conditions for the flow of Helium (He) gas as shown in the following sketch. Provide detailed information of assumptions, governing equations, dependent and independent variables, and numerical values of the boundary conditions.	[5]	1,4	4



PTO

Q.4 Answer the following questions pertaining to the finite volume method. 2 2

(a) Obtain an integral formulation of the governing equation $k\nabla^2 T + S = 0$ where *S* represents a distributed source of heat. [1]

(b) Provide a list of the steps followed to implement the finite volume method. [2]

(c) What are the advantages of the finite volume method? [2]

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