Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - VII EXAMINATION - WINTER 2025

Subject Code: 3170512 **Date: 01-12-2025**

Subject Name: Introduction to Computational Fluid Dynamics

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define Computational Fluid Dynamics (CFD) and state any two engineering applications	**03**
	(b)	Explain the importance of governing equations in Computational Fluid Dynamics (CFD)	**04**
	(c)	Discuss Computational Fluid Dynamics (CFD) as an engineering analysis tool with a suitable illustration.	**07**
Q.2	**(a)**	Define substantial derivative operator in vector notation and explain its physical significance.	**03**
	(b)	Discuss physical boundary conditions in Computational Fluid Dynamics (CFD) .	**04**
	(c)	Derive Navier–Stokes momentum equation for incompressible Newtonian fluid	**07**
		OR	
	(c)	Derive the substantial derivative and explain its importance in flow analysis	**07**
Q.3	**(a)**	Define a quasi-linear partial differential equation with one suitable example.	**03**
	(b)	Explain the discriminant method ($B^2 - 4AC$) for PDE classification.	**04**
	(c)	Compare elliptic, parabolic and hyperbolic PDEs with their physical interpretation in Computational Fluid Dynamics (CFD).	**07**
		OR	
	(a)	Differentiate between structured and unstructured grid.	**03**
	(b)	Discuss the mathematical behaviour of parabolic PDEs with examples	**04**
	(c)	Explain the eigenvalue method for classification of first-order PDE systems	**07**
Q.4	**(a)**	Define truncation error with an example.	**03**
	(b)	Compare explicit and implicit numerical approach.	**04**
	(c)	Explain Von Neumann stability method using suitable example.	**07**
		OR	
	(a)	Write the central difference formula for the first derivative $\partial u/\partial x$	**03**

	(b)	Give Classification of Quasi-Linear Partial Differential Equation.	**04**
	(c)	Explain different types of numerical errors in Computational Fluid Dynamics (CFD) with suitable example.	**07**
Q.5	**(a)**	List three Computational Fluid Dynamics (CFD) applications in reactor design	**03**
	(b)	Explain Computational Fluid Dynamics (CFD) application in agitator or mixing tank design.	**04**
	(c)	Explain Computational Fluid Dynamics (CFD) based design and analysis procedure for a Plug Flow Reactor	**07**

OR

	(a)	Write three Computational Fluid Dynamics (CFD) applications in furnace or combustion systems.	**03**
	(b)	Describe the application of Computational Fluid Dynamics (CFD) in dryer design	**04**
	(c)	Explain Computational Fluid Dynamics (CFD) based design and analysis procedure for a fluidized-bed reactor	**07**

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