Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2021

Subject Code:3170512 Date:29/12/2021

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.**

Q.1	**(a)**	What is computational fluid dynamics (CFD)? Write name of CFD software packages.	**03**
	(b)	Write applications of CFD in chemical engineering. Explain any one in detail.	**04**
	(c)	Write conservation and non-conservation form of continuity equation. Briefly describe each term. Differentiate between both of these forms of continuity equations.	**07**
Q.2	**(a)**	Write advantages and limitations of CFD.	**03**
	(b)	For second order partial derivative, $\left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j}$, derive second order accurate central finite difference equation using Taylor series.	**04**
	(c)	For moving fluid element, derive continuity equation in non-conservation form.	**07**
		OR	
	(c)	Discuss computational fluid dynamics as a research tool.	**07**
Q.3	**(a)**	Shock waves appears naturally in computational domain in shock capturing method. Agree or disagree? Justify your answer.	**03**
	(b)	Describe user activities at pre-processing stage in CFD.	**04**
	(c)	With suitable example, explain von Neumann stability method.	**07**
		OR	
Q.3	**(a)**	Explain the graphical concept of finite difference module. Write down first order forward and backward difference equation, showing their finite difference modules.	**07**
	(b)	For moving fluid element, derive momentum balance equation in non-conservation form.	**07**
Q.4	**(a)**	State the physical boundary conditions for a viscous flow.	**03**
	(b)	Differentiate between shock fitting method and shock capturing method.	**04**
	(c)	Write conservation form of continuity and momentum equations for	**07**

Inviscid flow. Differentiate between these equations and Navier-Stokes equations?

OR

Q.4	**(a)**	Define structured grid and unstructured grid.	**03**
	(b)	Write advantages and disadvantages of higher order accurate finite difference equations.	**04**
	(c)	Derive the finite difference expressions for first order derivative with forward, backward and central difference approximations, using Taylor series expansion.	**07**
Q.5	**(a)**	Define well-posed problems. What is Dirichlet boundary condition?	**03**
	(b)	Define Courant number and CFL condition in stability analysis. Explain their importance in stability analysis.	**04**
	(c)	Illustrate the use of conservation form of the equations so important for the shock-capturing method by considering the flow across a normal shock wave.	**07**

OR

Q.5	**(a)**	Define: (1) Discretization error, (2) Round-off error	**03**
	(b)	Differentiate between implicit approach and explicit approach for the solution of differential equations.	**04**
	(c)	Explain classification of quasi-linear partial differential equations based on Eigenvalue method.	**07**

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