U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**

Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 23ME6PECFD / 22ME6PECFD **Max Marks: 100**

Course: Computational Fluid Dynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	*CO*	*PO*	Marks
1	a)		Explain how CFD can be used as a research tool?.	*CO1*	*PO1*	**03**
	b)		What are the different flow models employed in CFD? Explain any two flow models with the help of neat sketch.	*CO1*	*PO1*	**07**
	c)		With the help of neat sketch derive a continuity equation for a finite control volume fixed in a space and fluid flowing through it.	*CO1*	*PO2*	**10**
			OR			
2	a)		Compare the Experimental, Theoretical, and Computational approaches on a fluid flow problem.	*CO1*	*PO1*	**03**
	b)		List the physical boundary conditions used in fluid flow and heat transfer problems. Explain any two types with the help of sketch.	*CO1*	*PO1*	**07**
	c)		Derive the momentum equation for an infinitesimally small fluid element moving with the viscous flow in a Cartesian space.	*CO1*	*PO2*	**10**
			UNIT - II			
3	a)		Compare the explicit and implicit discretisation approaches for the transient equations.	*CO2*	*PO1*	**05**
	b)		Using Cramer's rule classify the mathematical behavior of the equation $\frac{\partial^2\Phi}{\partial x^2} - \frac{\partial^2\Phi}{\partial y^2} = 0$	*CO2*	*PO2*	**05**
	c)		Derive the general conditions for classifying the partial differential equations using Cramer's rule.	*CO2*	*PO2*	**10**
			OR			
4	a)		What is discretization? List different discretization method generally used.	*CO2*	*PO1*	**05**
	b)		Derive the finite difference solution for a transient equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ using following schemes:	*CO2*	*PO2*	**05**

			(i) Implicit scheme and (ii) Explicit scheme.			
		c)	What is finite difference method? Explain the different finite difference methods (FDM) with the help of an example.	*CO2*	*PO1*	**10**
			UNIT - III			
	5	a)	Explain how the consistency of a system of non-homogeneous linear equations are determined using rank of the matrix?.	*CO3*	*PO1*	**05**
		b)	What are the steps involved in L-U decomposition method for solving the system of linear equations ?	*CO3*	*PO1*	**05**
		c)	Find the solution for the following system of linear equations using Gaussian elimination method. $2x + 2y + z = 12$ $3x + 2y + 2z = 8$ $5x + 10y - 8z = 10$	*CO3*	*PO2*	**10**
			OR			
	6	a)	Explain the steps involved in Gauss elimination method for solving the system of linear equations.	*CO3*	*PO1*	**08**
		b)	Find the solution for the following system of linear equations using Gauss Seidel method approximating up to 3 decimal places. Also verify the answer. $x_1+6x_3+10x_4 = 30.9$ $10x_2+8x_3+4x_4 = -3.8$ $10x_1+8x_2+6x_3 = 16.4$ $2x_1+10x_3+2x_4 = 36.9$	*CO3*	*PO2*	**12**
			UNIT - IV			
	7	a)	Define finite volume method and explain the steps involved.	*CO4*	*PO1*	**08**
		b)	The heat conduction in an insulated cylindrical rod takes place in axial direction such that its left and right ends are maintained at constant temperatures of 100 °C and 500 °C respectively. The one-dimensional problem is governed by diffusion equation $\frac{d}{dx}\left(kA\frac{dT}{dx}\right) = 0$. The thermal conductivity k of the rod is equal to 1000 W/m K, cross-sectional area A is 10×10^{-3} m^2. The length of the rod is 0.5 m. Divided the computational domain into five control volumes and derive the discretised equations for inner and boundary nodes. Calculate the coefficients and express the system of equations in to matrix.	*CO4*	*PO2*	**12**
			OR			
	8	a)	Compare Finite Volume Method (FVM) and Finite Element Method (FEM).	*CO4*	*PO2*	**05**
		b)	Explain the 4th Rule of Discretisation with the help of an example.	*CO4*	*PO1*	**03**
		c)	A property ϕ is transported by means of convection and diffusion in one-dimensional domain governed by $\frac{d}{dx}(\rho u\emptyset) = \frac{d}{dx}\left(\Gamma\frac{d\emptyset}{dx}\right)$. The length of the domain (L) is 1m. The boundary conditions are,	*CO4*	*PO2*	**12**

			$\phi_0 = 1$ at $x = 0$ (at left face) and $\phi_L = 0$ at $x = L$ (at right face). Take $\rho = 1.0$ kg/m^3, $\Gamma = 0.1$ kg/m s, and $u = 0.1$ m/s. Using five equally spaced cells derive the discretised equations for inner and boundary nodes. Calculate their coefficients and express the system of equations in matrix form.			
			UNIT - V			
	9	a)	What are the solution approaches for Navier Stokes equations? Explain the same.	*CO5*	*PO1*	**05**
		b)	List and explain the different types of grids used in FVM.	*CO5*	*PO1*	**05**
		c)	Explain how the pressure and velocity of momentum equation are coupled in SIMPLE and SIMPLER algorithm.	*CO5*	*PO1*	**10**
			OR			
	10	a)	What are the advantages and disadvantages of Stream function-Vorticity and Primitive variable approaches?	*CO5*	*PO1*	**08**
		b)	Compare Staggered grid and Colligated grid.	*CO5*	*PO1*	**06**
		c)	With an example discuss how staggered grids can overcome unrealistic pressure gradient of collocated grids?	*CO5*	*PO1*	**06**

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