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Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.

END SEMESTER EXAMINATION, MAY 2017

Max. Marks: 100

Duration: 4 Hrs

Class: M.Tech (Thermal), Semester: II

Program: M.Tech Mechanical with Thermal Engg. Subjects

COMPUTATIONAL FLUID DYNAMICS

Course Code : MTTH203

Instructions:

1. Question No. 1 is compulsory.
2. Attempt any four out of remaining six questions.
3. Assume suitable data if necessary with justification.

Master file.

Q. No.			Module No./CO. No.	Max. Marks
Q.1	(a)	Describe the overall methodology of executing numerical computation? How does it differs from experimental approach of investigation? Explain their relevance to investigate a thermal-fluid problem.	01/02	10
	(b)	Describe the need of modeling in a fluid flow problem?	01/02	05
	(c)	Explain the need and significance of boundary condition in numerical simulation. What are different types of thermal and flow boundary conditions?	03/01	05
Q.2	(a)	Differentiate between direct and iterative method of solving linear algebraic equation. Solve the following set of equations with TDMA method and Gauss Siedel method and compare the results? Assume $\varepsilon = 0.01$. $2x_1 - x_2 = 1,$ $-x_1 + 2x_2 - x_3 = 0,$ $-x_2 + 2x_3 - x_4 = 0,$ $-2x_3 + 2x_4 = 0.$	02/03	10
	(b)	Why iterative solution of linear algebraic equation needs to be relaxed? Explain successive under relaxation (SUR) and over relaxation (SOR) methods.	02/01	05
	(c)	Derive the forward and central difference equation for $\frac{\partial y}{\partial x}$ by FDM method. Comment on the accuracy of each of them.	04/01	05
Q.3	(a)	State differential form of basic conservation equations for heat and	03/02	10

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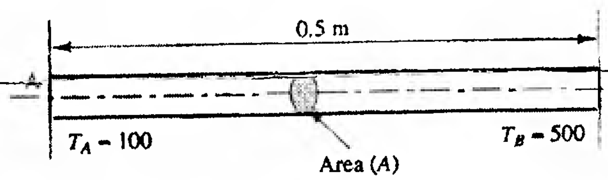
		fluid flow problem and explain physical meaning of each and every term. Derive generalized form of momentum equation for an infinitesimally small moving fluid element.		
	(b)	Explain the following terms related to meshing and state their impact on numerical solution. i) Aspect Ratio ii) Mesh Quality	04/01	05
	(c)	Consider two dimensional steady state heat conduction through a plate without internal heat generation. i) Write governing equation, ii) Derive the discretised form of governing equation with finite difference method.	05/04	05
Q.4	(a)	What do you mean spatial discretization? Name any two scheme for it and differentiate between them with their characteristic features.	~~04/01~~	~~05~~
	(b)	Consider conduction through a plate in one dimensional, steady state and without internal heat generation as given in fig. 1.  Fig. 1 i) Give governing equation in integral form. Also write BCs. ii) Show computation domain meshed with 5 cells. iii) Using FVM develop discretised form of cell equation and calculate the variation of temperature using appropriate method of solution. Thermal Conductivity k = 1000 W/m-K, cross sectional area $A = 10 \times 10^{-3}\ m^2$.	05/03, 04	15
Q.5	(a)	What is unsteady thermal system? Discuss any two approach of numerical modeling of such system. Consider unsteady state heat conduction through a plate of thickness 'L'. Write mathematical model for this case and convert it to discretised equation using the approaches proposed above. Analyze numerical stability related issues associated with the proposed methods.	05/04	10
	(b)	A property ϕ is transported by means of convection and diffusion through the one dimensional domain sketched in fig. 1 below. L = 1m,	06/04	10

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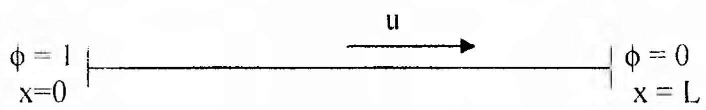
		$\rho = 1$ kg/m^3, $\Gamma = 0.1$ kg/m-s. a) Give the governing equation for the problem. b) Derive the discretised equation of the governing equation by the central differencing scheme and finite volume method. Calculate ϕ by taking five equally spaced cells and u = 0.1 m/s  Fig. 2		
Q.6	(a)	Consider 1D unsteady convection-diffusion problem without internal heat generation. Using descretization of governing equation, develop numerical stability criteria of the case and interpret it.	05/04	10
	(b)	Discuss the complexities associated with numerical modeling of flow problems. How does staggered grid helps to overcome these issues in incompressible fluid flow problems.	07/01	05
	(c)	What are different methods of solving flow problems? Explain the procedure of execution of one most popular flow solver.	07/02	05
Q.7	(a)	What do you understand by upwinding? State different upwind schemes. Prove and explain the limitation of central differencing scheme with the help of illustration.	06/01	10
	(b)	What is turbulent flow? State its characteristics.	07/01	05
	(c)	What are different turbulence models? Explain any one. State its advantages and disadvantages.	07/02	05