

2014
B.E. (Mechanical Engineering)
Eighth Semester
MEC-803: Computational Fluid Dynamics

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section. All questions carry equal marks.

x-x-x

1. (a) State practical applications of CFD in mechanical engineering.
- (b) What are the different fluid flow models? Brief them.
- (c) What are the different types of partial differential equations? Explain the physical behaviour of PDE.
- (d) Discuss the factors which contribute to errors in finite difference formulation.
- (e) What are the methods available for grid generation? Explain what is meant by staggered grid?

SECTION-A

2. (a) What are the reasons for rapid growth of CFD in recent times? Explain with an example how CFD is useful as a powerful research tool?
- (b) Explain the various steps involved in the process of computational fluid dynamics. Explain how CFD can be used as a design tool? What types of flow fields can now be adequately handled by CFD?
3. (a) Write down the governing equations of fluid flow, stating the assumptions in deriving the equation and then explain the significance of each term?
- (b) Derive the differential governing equation for fluid motion according to Newton's second law in conservation form.
4. (a) Identify the nature of the following system of PDEs:

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \quad \frac{\partial u}{\partial y} = v, \text{ where } u, v \text{ are the two dependent variables.}$$

- (b) Prove that the classification of the PDE: $(1 - 2M^2) \frac{\partial^2 \rho}{\partial x^2} + \frac{\partial^2 \rho}{\partial y^2} = 0$, is different for different values of the parameter M. (4 + 4 + 2)
- (c) What are the different categories of physical boundary conditions? Give example of each category. Why boundary conditions are needed? State their importance in solving fluid flow problem.

P.T.O.

(2)

SECTION-B

5. (a) What is discretization? Why it is required? Differentiate between the implicit and explicit methods of discretization of the partial differential equations.
- (b) How do you determine the accuracy of the discretization process? What are the uses and difficulties of approximating the derivatives with higher order finite difference schemes? How do you overcome these difficulties?
- (c) Write a notes on (i) Consistency, (ii) Stability. (3 + 4 + 3)
6. (a) Discuss the properties of discretization schemes and explain upwind discretization applied to finite volume method.
- (b) Discuss about 2-D convection diffusion equation by using quadratic upwind difference scheme.
7. Explain the concept of SIMPLE algorithm with pressure correction and velocity correction equations for incompressible fluid and give the importance of SIMPLER algorithm.

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