CBCS SCHEME

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18AE72

Seventh Semester B.E. Degree Examination, Jan./Feb. 2023
Computational Fluid Dynamics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Derive the momentum equation considering an infinitesimally small fluid element moving with the flow, for an unsteady. Three dimensional, compressible and various flow with visual notations. **(10 Marks)**

b. Why is CFD a research tool? Elaborate its importance in aerospace and non-aerospace applications. **(10 Marks)**

OR

2 a. Given the general form of governing equation suitable for CFD in case of steady, inviscid flow by explaining the terms involved in it and describe the procedure of obtaining primitive variables of the same. **(10 Marks)**

b. Explain the following terms:
(i) Dirichlet and Nuemann Boundary conditions.
(ii) Shock-capturing and shock fitting methods **(10 Marks)**

Module-2

3 a. Apply Cramer's rule to a quasilinear partial differential equation for the mathematical classification as elliptic, hyperbolic and parabolic. **(10 Marks)**

b. Explain the impact of partial differential equation classifications on unsteady thermal conduction phenomenon. **(10 Marks)**

OR

4 a. Explain unsteady thermal conduction through a semi infinite fluid by writing governing equation and plotting typical solution characteristics. **(10 Marks)**

b. Explain the behaviour of hyperbolic equations and its impact on steady, in viscid supersonic flow field. **(10 Marks)**

Module-3

5 a. What are adaptive grids? Describe two types of grid adaptive methods. **(10 Marks)**

b. With suitable sketches, explain the features of structured grids and un structured grids. **(10 Marks)**

OR

6 a. Elaborate on the following structured grid generation techniques:
(i) Algebraic grid generation method
(ii) Numerical grid generation method **(10 Marks)**

b. Define grid quality. List the measures of quality and explain in detail. **(10 Marks)**

Module-4

7 a. Demonstrate the explicit and implicit approach of solving CFD problems. List their advantages and disadvantages. **(10 Marks)**

b. Explain the importance of discretisation and transformation in CFD. **(10 Marks)**

OR

8 a. Elaborate matrics and Jacobian determinant and show the application of metrics in Laplace equation, $\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}=0$. **(10 Marks)**

b. Obtain the generic form of governing flow equations with strong conservative form in transformed space. **(10 Marks)**

Module-5

9 a. Explain briefly the following spatial discretisation technique:
(i) Cell-centered technique
(ii) Cell-vertex technique **(10 Marks)**

b. Give a short note on the following:
(i) Flux vector splitting
(ii) Artificial dissipation **(10 Marks)**

OR

10 a. Explain briefly the following temporal discretisation technique:
(i) Explicit time stepping
(ii) Implicit time stepping **(10 Marks)**

b. Construct a finite volume discritisation scheme on one dimensional steady heat conduction equation $K\left(\frac{d^2T}{dx^2}\right)+S=0$, where K is thermal conductivity of the material. T is the temperature and S is a source of head. **(10 Marks)**

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