CBCS SCHEME

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15AE72

Seventh Semester B.E. Degree Examination, Jan./Feb.2021
Computational Fluid Dynamics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. What is the philosophy of CFD and what are some of its applications? **(08 Marks)**

b. Highlight different models of flow. Explain substantial derivative and physical meaning of divergence of velocity. **(08 Marks)**

OR

2 a. Explain the following terms:
(i) Dirichlet and Nuemann Boundary conditions.
(ii) Shock-capturing and shock filling methods.
(iii) Viscous flow and inviscid flow. **(09 Marks)**

b. Describe general comments on partial differential equation and write no-slip boundary condition. **(07 Marks)**

Module-2

3 a. How does a quasi-linear partial differential equation get classified? Explain it using Cramer's rule. **(10 Marks)**

b. Explain the impact of classification of PDE on physical and computational fluid dynamics. **(06 Marks)**

OR

4 a. Compare and contrast the general behaviors of partial differential equations with suitable examples and neat diagrams. **(10 Marks)**

b. Identify the type of partial differential equations,

(i) $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$.

(ii) $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$, where α is a constant.

(iii) $\frac{\partial^2 u}{\partial t^2} + C^2 \frac{\partial^2 u}{\partial x^2} = 0$, where C is a constant. **(06 Marks)**

Module-3

5 a. Explain the features of the following:
(i) Structured grids.
(ii) Unstructured grids. **(10 Marks)**

b. Elaborate on algebraic grid generation. **(06 Marks)**

OR

6 What are adaptive grids? Describe two types of grid adaptive methods. **(16 Marks)**

Module-4

7 a. Approximate the continuity equation, $\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0$, using finite difference method. (04 Marks)

b. Elaborate on following terms:
   (i) Errors and stability analysis.
   (ii) Lax-Wendroff method.
   (iii) Time and Space Marching. (12 Marks)

OR

8 a. Explain the reason and the way of transformation from a physical plane to a computational plane with neat sketches. (06 Marks)

b. 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)

Module-5

9 a. With neat sketches, elucidate vertex-centered and dual cell control volume schemes and their underlying concepts. (09 Marks)

b. Explain temporal discritisation using explicit and implicit time stepping methods. (07 Marks)

OR

10 a. 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)

b. Show the fundamental difference between FDM and FVM through diagrams for a 1-D 2nd order partial differential equation. (06 Marks)

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