CBCS SCHEME

USN ⬚⬚⬚⬚⬚⬚⬚⬚⬚⬚ **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) $\dfrac{\partial^2 T}{\partial x^2} + \dfrac{\partial^2 T}{\partial y^2} = 0$.

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

      (iii) $\dfrac{\partial^2 u}{\partial t^2} + C^2 \dfrac{\partial^2 u}{\partial x^2} = 0$, 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, $\dfrac{\partial u}{\partial x} + \dfrac{\partial v}{\partial y} = 0$, 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, $\dfrac{\partial^2 T}{\partial x^2} + \dfrac{\partial^2 T}{\partial y^2} = 0$.   (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. $K\left(\dfrac{d^2 T}{dx^2}\right) + S = 0$, 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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