Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE013

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech VI Semester End Examinations (Regular) - May, 2019

Regulation: IARE – R16

Computational Aerodynamics

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Discuss how Computational Fluid Dynamics (CFD) is vital in the following fields. **[7M]**
   i. Automobile engineering
   ii. Industrial manufacturing
   iii. Civil engineering **[7M]**

   (b) Write down the most generic form of a partial differential equation used in CFD and explain the significance of each term.

2. (a) Discuss from which industry CFD has emerged from. Write some advantages and disadvantages of using CFD. **[7M]**

   (b) Discuss with a neat diagram shock capturing method along with its merits and demerits. Explain why conservation form of governing equations is important for calculations using shock capturing method. **[7M]**

UNIT – II

3. (a) Differentiate between the finite volume method and finite difference method. **[7M]**

   (b) What are characteristic lines? Explain the philosophy of the method of characteristics. Consider the full velocity potential equation for the steady, two dimensional supersonic flows and determine the equation for characteristic curves in the physical xy space and classify the nature of velocity potential equation based on Mach number. **[7M]**

4. (a) Classify the following partial differential equations according to their nature as elliptic, parabolic, hyperbolic
   i. Unsteady Thermal Conduction Equation
   ii. Laplace's Equation
   iii. Second-order wave equation
   iv. First-order wave equation **[7M]**

   (b) Explain the classification of the following quasi-linear partial differential equations using Cramer's rule:
   $a_1(\partial u/\partial x) + b_1(\partial u/\partial y) + c_1(\partial v/\partial x) + d_1(\partial v/\partial y) = f_1$
   $a_2(\partial u/\partial x) + b_2(\partial u/\partial y) + c_2(\partial v/\partial x) + d_2(\partial v/\partial y) = f_2$
   Where u and v are dependent variables, continuous functions of x and y and a_1, a_2, b_1, b_2, c_1,c_2, d_1, d_2, f_1, f_2 can be functions of x, y, u and v. **[7M]**

UNIT – III

5. (a) Discuss the main advantages and disadvantages of discretization of the governing equations through the finite difference method. **[7M]**

   (b) Explain Lax method for one dimensional wave equation and explain the stability criterion for hyperbolic equations. **[7M]**

6. (a) Highlight the explicit formulation by using one dimensional heat conduction equation as an example with its relative merits and demerits. **[7M]**

   (b) Discuss the H-O-H mesh? Explain it with neat sketch and its applications. **[7M]**

UNIT – IV

7. (a) Elucidate the Mac-Cormack's explicit finite difference technique and discuss its advantage over Lax-Wendroff method. **[7M]**

   (b) Describe the SIMPLE algorithm step by step for estimation of velocity and pressure fields in solving incompressible viscous flow problems.

   [7M]

8. (a) Explain pressure correction technique and also discuss what is the need for staggered grid. **[7M]**

   (b) Explain Crank-Nicolson implicit scheme used for solving the parabolic partial differential equations. **[7M]**

UNIT – V

9. (a) Explain the two-dimensional finite volume method and describe evaluation of fluxes through cell surfaces using central discretization schemes **[7M]**

   (b) Define finite volume discretization and explain the features which distinguish the interpretation of finite volume methods from the finite difference approach . **[7M]**

10. (a) Derive the formulation for numerical scheme in discretization and differentiate the structured and unstructured mesh.

    [7M]

    (b) Implicit cell-centered and cell-vertex discretization methodologies used in Finite volume approach with the help of sketches. What are the constraints to be satisfied on the choice of discretized control volumes for a consistent finite volume method? **[7M]**

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