Code No: M2122/R07 **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, Feb/Mar 2011
COMPUTATIONAL AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) How Computational Fluid Dynamics is helpful as a research tool? Illustrate with an example?
   (b) How Computational Fluid Dynamics is useful as a design tool? Illustrate with an example? [8+8]
2. Explain conservation and non-conservation forms of governing flow equations with illustrations from continuity equation. Comment on Integral versus differential form of the governing flow equations. [16]
3. Write short notes on the following:
   (a) Strong and weak conservation forms of governing equations.
   (b) Shock capturing method. [8+8]
4. Write short notes on the following:
   (a) Characteristic curves.
   (b) Domain of dependence and range of influence. [8+8]
5. (a) Explain about the FDM,FVM, FEM.
   (b) Write difference equation for $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$ [12+4]
6. What is the need of transformation of curvilinear, non uniform grid in physical plane to rectangular grid in computational plane? And also explain why the governing equations must be transformed from (x, y) to (ξ, η) as the new independent variables, with suitable derivations for first and second derivatives. [16]
7. What are the available structured grid generation techniques and explain elliptic grid generation. [16]
8. Write a short notes on:
   (a) Elliptic grid
   (b) Parabolic grid
   (c) Hyperbolic grid. [5+5+6]

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Code No: M2122/R07 **Set No. 2**

IV B.Tech I Semester Supplementary Examinations, Feb/Mar 2011
COMPUTATIONAL AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Write short notes on the following:
   (a) Physical Meaning of Substantial derivative
   (b) Vector processors. [8+8]
2. Derive the energy equation in terms of total energy for a viscous flow on the basis of flow model of infinitesimally small fluid element moving with the flow. [16]
3. Comment upon the statement "Shock waves are common phenomena in high speed aerodynamics". What are the methods used to handle them in computational aerodynamics? What are their advantages and disadvantages? [16]
4. Discuss the mathematical and physical behavior of flows governed by parabolic equations with an example of unsteady thermal conduction in two and three dimensions. [16]
5. (a) Explain about the FDM,FVM, FEM.
   (b) Write difference equation for $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$ [12+4]
6. Show that with a generalized coordinate transformation, the equation $\frac{\partial u}{\partial x} + \frac{\partial \nu}{\partial y} = 0$ many be expressed as $\frac{\partial \overline{U}}{\partial \xi} + \frac{\partial \overline{V}}{\partial \eta} = 0$ where $\overline{U} = \frac{U}{J}, \overline{V} = \frac{V}{J}$ and $U = u\xi_x + \vartheta\xi_y,\ \ V = \mathrm{u}\eta_x + \vartheta\eta_y$. [16]
7. (a) What is the difference between structured grid and unstructured grid?
   (b) Write a short note on principle of structured mesh generation. [8+8]
8. Write a short notes on:
   (a) Elliptic grid
   (b) Parabolic grid
   (c) Hyperbolic grid. [5+5+6]

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Code No: M2122/R07 **Set No. 3**

IV B.Tech I Semester Supplementary Examinations, Feb/Mar 2011
COMPUTATIONAL AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. What is Computational Fluid Dynamics? Illustrate any two applications of CFD in Automobile industry? [16]

2. Derive the energy equation in terms of total energy for a viscous flow on the basis of flow model of infinitesimally small fluid element moving with the flow. [16]

3. (a) Discuss with a neat diagram shock capturing method along with its merits and demerits.
   (b) Explain why conservation form of governing equations is important for calculations using shock capturing method. [8+8]

4. (a) Classify the following partial differential equations:
      i. Unsteady Thermal Conduction Equation: $\partial T/\partial t = \alpha \partial^2 T/\partial t^2$
      ii. Laplace's Equation: $\partial^2\phi/\partial x^2 + \partial^2\phi/\partial y^2 = 0$
   (b) Explain what do you understand by domain of dependence and range of influence with an example. [4+4+8]

5. (a) Explain the implicit formulation with an example.
   (b) What is the use of Thomas algorithm. [12+4]

6. Show that with a generalized coordinate transformation, the equation $\frac{\partial u}{\partial x} + \frac{\partial \nu}{\partial y} = 0$ many be expressed as $\frac{\partial \overline{U}}{\partial \xi} + \frac{\partial \overline{V}}{\partial \eta} = 0$ where $\overline{U} = \frac{U}{J}, \overline{V} = \frac{V}{J}$ and $U = u\xi_x + \vartheta\xi_y,\ \ V = \mathrm{u}\eta_x + \vartheta\eta_y$. [16]

7. Explain the elliptic grid generation with simply connected domain and doubly connected domain. [16]

8. Write a short notes on:
   (a) Elliptic grid
   (b) Parabolic grid
   (c) Hyperbolic grid. [5+5+6]

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Code No: M2122/R07 **Set No. 4**

IV B.Tech I Semester Supplementary Examinations, Feb/Mar 2011
COMPUTATIONAL AERODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Illustrate with an example from aerospace applications about the importance of computational fluid dynamics in modern analysis of fluid flow problems.
   (b) Explain what are vector processors and parallel processors and explain their role in computational fluid dynamics. [8+8]
2. (a) Derive the continuity equation $D\rho$ /Dt + $\rho\nabla \bullet \nabla = 0$ assuming appropriate flow model. Convert this equation to conservation form.
   (b) What are the different types of temperature boundary conditions that are generally prescribed on the surface of a body in viscous flows? [10+6]
3. (a) Why computational fluid dynamics makes a distinction between conservation and non-conservation forms of governing equations? Explain with examples.
   (b) Why integral form of governing equations can be considered as more fundamental than differential form? Discuss with examples. [8+8]
4. Write short notes on the following:
   (a) Characteristic curves.
   (b) Domain of dependence and range of influence. [8+8]
5. Explain Von Newmann stability analysis with an example. [16]
6. What is the need of transformation of curvilinear, non uniform grid in physical plane to rectangular grid in computational plane? And also explain why the governing equations must be transformed from (x, y) to (ξ, η) as the new independent variables, with suitable derivations for first and second derivatives. [16]
7. What are the available structured grid generation techniques and explain the conformal mapping method. [16]
8. (a) What is hyperbolic grid generation? Explain its advantages and applications.
   (b) How to form hyperbolic grid by using cell area (jacobian) method? [8+8]

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