Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 150104 Sub Name: Computational Fluid Dynamics-I

Date: 18 /12 /2010 Time: 03.00 pm - 05.30 pm

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive the energy equation for a viscous flow with heat transfer in non conservation form. **07**

(b) Justify CFD is a research tool. Write and explain the steps involved in CFD process. **07**

Q.2 **(a)** What is the difference between the Euler's model and Navier stokes model of equations? Write the generic form of Navier Stokes model. **07**

(b) Explain the supersonic flow over the nose of a blunt body. Write a short note on shock capturing method. **07**

OR

(b) Consider the irrotational, 2-D, inviscid, steady flow of a compressible gas. The flow field is slightly perturbed from free seam like flow over a thin profile. Find the roots of equations involved in such kind of flow problem using Cramer's rule and Eigen method. **07**

Q.3 **(a)** Distinguish between the basic discretization techniques. Derive the expression for 1st order forward, 1st order rearward and 2nd order central difference equation with respect to x. **07**

(b) Explain the domain and boundaries for the solution of parabolic equation in 2-D. also explain the steady boundary layer flows over a body. **07**

OR

Q.3 **(a)** Derive the differential equation to unsteady 1-D heat conduction equation. Also define the accurate solution and precise solution. **07**

(b) Write a short note on Lax Wendroff method and gives its stability criteria. **07**

Q.4 **(a)** Differentiating between explicit approach and implicit approach for the solution of difference equations. Formulate the explicit form for 1-D heat conduction equation. **07**

(b) With an example explain the concept of compressed grid. **07**

OR

Q.4 **(a)** Describe Mac Cormark multi-step method. **07**

(b) Consider the viscous flow of air over a flat plate. Variation in velocity with respect to y is given as: $u=1582(1-e^{-y/L})$. Where L= 1 unit and $\mu=3.37\times10^{-7}$slug/ (ft.s). y is from 0 to 0.3 in the steps of 0.1. Find the percentage error in shear stress, involved in 1st ordered and 2nd ordered difference compared to exact solution. **07**

Q.5 **(a)** Draw and explain the subsonic-supersonic flow through the C-D nozzle and also show the variation in properties along the length of nozzle **07**

(b) Derive the momentum equation for the 2-D subsonic supersonic flow through C-D nozzle. **07**

OR

Q.5 **(a)** How the boundary conditions and initial conditions are applied to the nozzle flow. **07**

(b) Why the governing equations are to be transformed into non dimensional form? Derive the momentum equation in non dimensional form for the nozzle flow. **07**

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