Printed Pages : 3

ECH-022

(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 151655**

Roll No. | | | | | | | | | | |

# B. Tech.

## (SEM. VI) THEORY EXAMINATION, 2014-15

## COMPUTATIONAL FLUID DYNAMICS

Time : **2** Hours] [Total Marks : **50**

Note: Attempt all questions. All questions carry equal marks.

1. Attempt any four parts of the following: $3 \times 4 = 12$

   (a) Give two industrial applications where application of CFD techniques would be very useful and two more in which CFD would not be able to contribute much.

   (b) What is the boundary condition when fully developed pipe flow becomes thermally developed?

   (c) What is the relative advantage of direct numerical simulation (DNS) in turbulent flow simulation?

   (d) Describe Osher's approximate Riemann solver.

   (e) State the advantages and disadvantages of explicit and implicit approaches.

(f) Write down momentum equation for laminar natural convection in the direction of gravity.

2. Attempt any two parts of the following: $6\times2=12$

(a) Derive second order accurate central and one-sided approximations for the three derivates on a non-uniform grid. State the disadvantages of Lax-Wendroff Technique.

(b) Explore the accuracy, consistency and stability of the Beam-Warming scheme, and the MacCormack scheme for the unsteady advection case.

(c) Discuss the over relaxation factor. What are the numerical errors? Explain with illustration.

3. Attempt any two parts of the following: $7\times2=14$

(a) How do you determine the accuracy of the discretization process? What are the uses and difficulties of approximating the derivatives with higher order finite difference schemes? How do you overcome these difficulties?

(b) What is cell centered formulation? Explain with the help of using control volume, semi discretization equation,

$$\Omega_{ij}\, \partial U / \partial t + \int F.nds = 0$$

(c) Solve the simplified Sturn-Lioville equation :

$\dfrac{\partial^2 y}{\partial x^2} + y = F$ With boundary conditions $y(0) = 0$

and $\dfrac{\partial y}{\partial x}(1) = 0$; using Galerkin finite element method.

4. Attempt any two parts of the following: 6×2=12

(a) A sphere initially at a temperature of $T_i$, loses heat by convection to a fluid at temperature $\Gamma F$ . assuming that the heat transfer coefficient h at any point is of the form h=$-9X^{0.5}+b$ where x is the distance from the forward stagnation point (along the surface). Formulate the nodal equation for temperature variation inside the sphere by finite difference method.

(b) Deploy the k-$\varepsilon$ model for turbulent flow in a tube assuming appropriate boundary condition and then discretize the flow direction momentum equation in finite volume method.

(c) Draw and explain the subsonic-supersonic flow through the C-D nozzle and also show the variation in properties along the length of nozzle.

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