Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER II– EXAMINATION – SUMMER 2015

Subject Code: 2722106 **Date: 28/05/2015**

Subject Name: Computational Fluid dynamics

Time: 2:30 PM – 5:00 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)** What is CFD ? How does a CFD code works ? **07**

(b) Give classification of quasi linear partial differential equation. (Cramerôs Rule). **07**

Q.2 **(a)** By using Taylorôs series expansion derive **07**

1. Second order central second difference

Second order central difference for mixed derivatives.

(b) Derive **07**

$$\left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} = \frac{-u_{i+2,j} + 16u_{i+1,j} - 30u_{i,j} + 16u_{i-1,j} - u_{i-2,j}}{12\Delta x^2} + O(\Delta x)^4$$

OR

(b) Derive (one sided) **07**

$$\left(\frac{\partial u}{\partial x}\right)_{i,j} = \frac{1}{6\Delta y}\left(-11u_{i,j} + 18u_{i,j+1} - 9u_{i,j+2} + 2u_{i,j+3}\right) + O(\Delta x)^3$$

Q.3 **(a)** Write short note on Adaptive Grids **07**

(b) Explain Lax Wandroff Technique in brief **07**

OR

Q.3 **(a)** Explain Maccormackôs Technique in brief **07**

(b) Show that the pressure correction formula is a central difference formulation of Poissonôs equation for the pressure correction. **07**

Q.4 **(a)** Explain Finite Volume Method for one dimensional steady state conduction **07**

(b) A property $\emptyset$ is transported by means of convection and diffusion through the one – dimensional domain sketched in Figure – 1. The boundary conditions are $\emptyset_O = 1$ at $x = 0$ and $\emptyset_L = 0$ at $x = L$using five equally spaced cells and the central differencing scheme for convection and diffusion, calculate the distribution of $\emptyset$ as a function of x for (i) Case – 1 $u = 0.1\ m/s$ and (ii) Case – 2 $u = 2.5\ m/s$ **07**

OR

Q.4 **(a)** Consider the problem of source free heat conduction in an insulated rod whose ends are maintained at constant temperatures of 100°C and 500°C respectively. The one-dimensional problem sketched in Figure ï 2 is governed by **07**

$$\frac{d}{dx}\left(k\frac{dT}{dx}\right) = 0$$

Calculate the steady state temperature distribution in the road. Thermal conductivity k equals 1000 W/mK, cross ï sectional area A is 0.001 m^2

(b) Explain One DimensionalUpwind difference scheme for Conduction ï Convection problem.. **07**

Q.5 **(a)** Explain SIMPLE algorithm **07**

(b) (1) Discuss Implicit methods are unconditionally stable. **07**

(2) Disadvantage of Implicit approach.

OR

Q.5 **(a)** Explain Staggered grid. **07**

(b) Explain Quadratic Upstream Interpolation for Convective Kinetics **07**

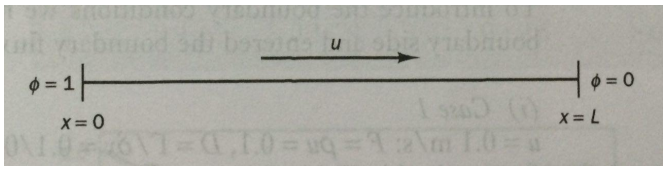

Figure – 1

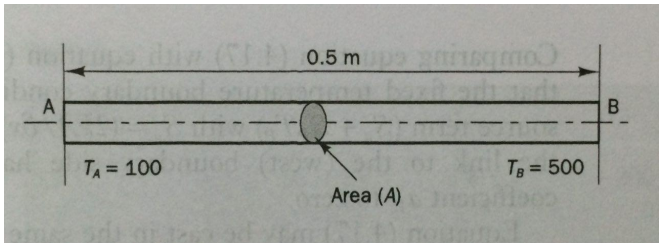

Figure - 2