Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME SEMESTER II EXAMINATION – SUMMER 2017**

**Subject Code: 2722106** **Date:29/05/2017**

**Subject Name: Computational Fluid Dynamics**

**Time:02:30 PM to 05:00 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. (Cramer's Rule) | **07** |
| **Q.2** | **(a)** | By using Taylor's series expansion derive<br>1. Second order central second difference<br>2. Second order central difference for mixed derivatives. | **07** |
| | **(b)** | Derive<br>$$\left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} = \frac{-u_{i+2,j} + 16u_{i+1,j} - 30u_{i,j} + 16u_{i-1,j} - u_{i-2,j}}{12\Delta x^2} + O(\Delta x)^4$$ | **07** |
| | | **OR** | |
| | **(b)** | Derive (one sided)<br>$$\left(\frac{\partial u}{\partial x}\right)_{i,j} = \frac{1}{6\Delta y}\left(-11u_{i,j} + 18u_{i,j+1} - 9u_{i,j+2} + 2u_{i,j+3}\right) + O(\Delta x)^3$$ | **07** |
| **Q.3** | **(a)** | Write short note on Adaptive Grids | **07** |
| | **(b)** | Explain Lax Wandroff Technique in brief | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Explain Maccormack's Technique in brief | **07** |
| | **(b)** | Show that the pressure correction formula is a central difference formulation of Poisson's 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$^{O}$C and 500$^{O}$C respectively. The one-dimensional problem sketched in Figure – 2 is governed by<br>$$\frac{d}{dx}\left(k\frac{dT}{dx}\right) = 0$$<br>Calculate the steady state temperature distribution in the road. Thermal conductivity k equals 1000 W/mK, cross – sectional area A is 0.001 m$^2$ | **07** |
| | **(b)** | Explain One Dimensional Upwind difference scheme for Conduction – Convection problem. | **07** |
| **Q.5** | **(a)** | Explain SIMPLE algorithm | **07** |
| | **(b)** | (1) Discuss Implicit methods are unconditionally stable.<br>(2) Disadvantage of Implicit approach. | **07** |

**OR**

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

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

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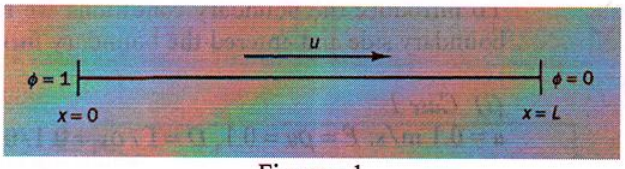


Figure – 1

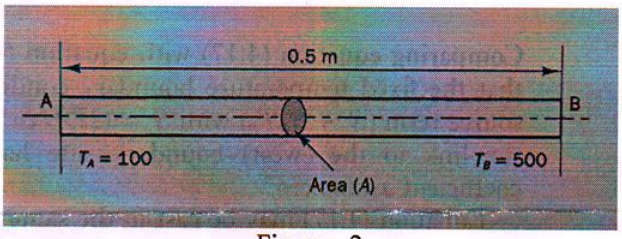


Figure – 2