Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014

Subject code: 1721005 **Date: 05-12-2014**

Subject Name: Computational Fluid Dynamics

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

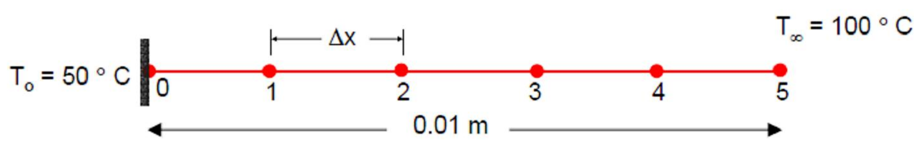
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain CFD analysis process in details. **07**

(b) Explain in details advantages, disadvantages and source of errors for experiments and numerical simulations **07**

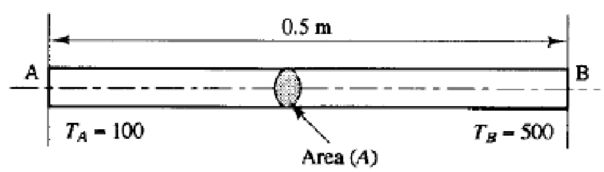
Q.2 **(a)** Using appropriate example explain finite volume method for one dimensional steady state diffusion problem **07**

(b) Consider the steady state heat conduction in a slab of thickness L, in which energy is generated at a constant rate of S W/m3 as shown in Figure. The boundary surface at x = 0 is maintained at a constant temperature T_o, while the boundary surface at x = 0 dissipates heat by convection with a heat transfer coefficient h into an ambient at temperature $T_Ð$. Compute the temperature inside the slab for h = 200 W/ (m^2/°C), k = 18 W/(m/°C), L = 0.01 m, $T_Ð$ = 100°C, T_o = 50°C, and S = 7.2 x 10^7. The governing equation is $k\frac{d^2T}{dx^2} + S = 0$ **07**



OR

(b) 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 as shown in figure. Calculate the steady state temperature in the rod. Take thermal conductivity *k* = 1000 W/mK, cross-sectional area *A* = 10×10^{-3} **07**



Q.3 **(a)** Explain staggered, Unstaggered and partially staggered grid **07**

(b) Explain *Courant–Friedrichs-Lewy* (CFL) stability criterion for hyperbolic equation $\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = 0$ **07**

OR

Q.3 **(a)** Derive continuity equation in conservative integral form and then convert into non-conservative differential form **07**

	(b)	Consider non linear equation $u\frac{\partial u}{\partial x}=\mu\frac{\partial^2 u}{\partial^2 y}$ where μ is a constant, u the x component of velocity, and y is the direction normal to x. Is this equation in conservative form? If not suggest a conservative form of the equation. Develop finite difference scheme for this equation for x direction.	**07**
Q.4	**(a)**	Derive Navier-Stokes equation	**07**
	(b)	Establish the truncation error of the following finite difference approximation to $\partial T/\partial y$ at the point (i,j) for a uniform mesh. $\frac{\partial T}{\partial y}=\frac{-3T_{i,j}+4T_{i,j+1}-T_{i,j+2}}{2(\Delta y)}$ What is the order of truncation error?	**07**

OR

Q.4	**(a)**	Derive Reynolds Transport Theorem (RTT)	**07**
	(b)	Consider steady, incompressible flow over an infinitely long cylinder of radius R_0. Explain boundary condition for stream function and vorticity formulation for the given flow geometry.	**07**
Q.5	**(a)**	What are the important concepts on which MAC algorithm is based?	**07**
	(b)	Explain four basic rules for formulation of SIMPLE algorithm based on finite volume discretization.	**07**

OR

Q.5	**(a)**	Explain turbulence and turbulent flow. List the characteristic s of turbulent flow.	**07**
	(b)	Why turbulence Modelling is necessary? Classify and explain various turbulence models	**07**