

GUJARAT TECHNOLOGICAL UNIVERSITY**M. E. - SEMESTER – II • EXAMINATION – WINTER • 2013****Subject code: 1721005****Date: 02-01-2014****Subject Name: Computational Fluid Dynamics****Time: 10.30 am – 01.00 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) Give the classification of quasi-linear partial differential equation. **07**

(b) Derive: $\left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} = \frac{-u_{i+2,j} + 16u_{i+1,j} - 30u_{i,j} + 16u_{i-1,j} - u_{i-2,j}}{12(\Delta x)^2} + O(\Delta x)^4$ **07**

Q.2 (a) What are Neumann and Dirichlet boundary conditions? Explain various types of boundary conditions. **07**

(b) Discretize the 1D unsteady heat conduction equation in an explicit finite difference scheme and discuss its stability. **07**

OR

(b) Discuss the difference between Explicit and Implicit finite difference scheme in brief. **07**

Q.3 (a) Discuss the difference between finite difference and finite volume method. **07**

(b) Consider a large Uranium plate of thickness $L = 4$ cm and thermal conductivity $k = 28 \text{ W/m}^3\text{K}$ in which heat is generated uniformly at a constant rate of $5 \times 10^6 \text{ W/m}^3$. One side of the plate is maintained at 0°C by ice water while the other side is subjected to convection to an environment at $T = 30^\circ\text{C}$ with a heat transfer coefficient of $h = 45 \text{ W/m}^2\text{K}$. Considering a total of three equally spaced nodes in the medium, two at the boundaries and one at the middle, estimate the exposed surface temperature of the plate under steady conditions using the finite difference approach. **07**

OR

Q.3 (a) Formulate the 1D linear element, 1D quadratic element, 2D linear triangular elements of finite element method. **07**

(b) Formulate the 1D convection diffusion equations using finite element method. **07**

Q.4 (a) Write a note on Cell-Centred and Cell-Vertex Schemes of finite volume method. **07**

(b) Write a note on structured and unstructured grid in finite volume method for complex geometry. **07**

OR

Q.4 (a) Give brief introduction of MAC (Marker & Cell) method to solve the unsteady Navier-Stokes equations. **07**

(b) Write notes on upwind difference scheme of finite volume method. **07**

Q.5 (a) Discuss advantages and disadvantages of stream function- vorticity formulation approach for solving viscous incompressible flows. **07**

(b) Explain different discretization techniques used in CFD. **07**

OR

Q.5 (a) State and explain advantages and limitations of finite volume method. **07**

(b) Derive two dimensional scalar transport equation **07**
