Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. Sem. – IInd - Examination – June/July- 2011

Subject code: 1721005

Subject Name: Computational Fluid Dynamics

Date:29/06/2011 **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)** Derive integral form of momentum conservation equation along x-direction. **07**

(b) Explain the process of discretization of conservation equations used in CFD **07**

Q.2 **(a).** Explain following discretization properties**.** **07**
(I) Consistency (ii) Stability and (iii) Order.

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

OR

(b) Explain central differencing and up wind differencing. **07**

Q.3 **(a)** Prove that the vortecity vector is the curl of the velocity vector. **07**

(b) Write one dimensional scalar transport equation and explain advection, diffusion and source. **07**

OR

Q.3 **(a)** State and explain advantages and limitations of finite element method. **07**

(b) Consider a large uranium plate of thickness L= 4 cm and thermal conductivity k = 28 W/my in which heat is generated uniformly at a constant rate of 5x10^6 W/m3. One side of the plate is maintained at 0°C by iced water while the other side is subjected to convection to an environment at T= 30°C with a heat transfer coefficient of h= 45 W/m^{2}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**

Q.4 **(a)** Discuss the advantages and limitations of computational fluid dynamics. **07**

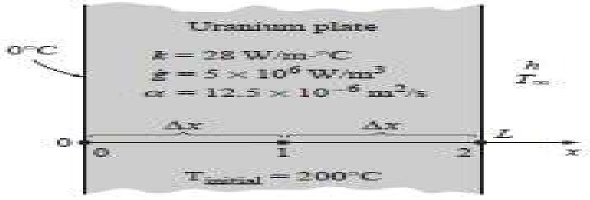
(b) Discuss basic methodology of finite difference method and finite volume method. **07**

OR

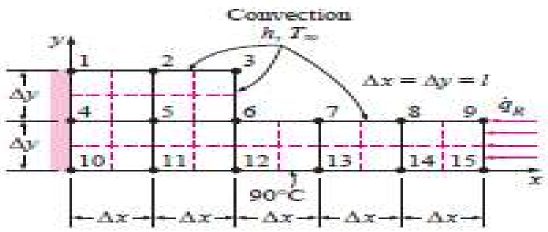
Q.4 **(a)** Derive integral form of general equation of heat conduction in Cartesian co-ordinates. **07**

(b) Consider a large uranium plate at uniform temperature of 200^{0}C has thickness 4 cm, thermal conductivity k= 28 W/my, and thermal diffusivity α=12.5x 10^6 m2/s .Heat is generated uniformly at a constant rate of 5x10^6 W/m3. one side of the plate is maintained at 0°C all times, while the other side is exposed to convective environment of 30°C and heat transfer coefficient45 W/m2K, 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 **07**

the plate 2.5 min after the start of cooling using the explicit method.



Q.5	**(a)**	State and explain various types of errors that occur during CFD simulation.	**07**
	(b)	Consider steady heat transfer in an L-shaped solid body. Heat transfer in the direction normal to the plane of the paper is negligible, and thus heat transfer in the body is two-dimensional. The thermal conductivity of the body is 15 W/m K, and heat generated in the body is at a rate of 2x 10^6 W/m3. The left surface of the body is insulated, and bottom surface is maintained at a temperature of 90 °C. The entire top surface is subjected to convection to ambient air at 25°C with a convection coefficient of 80 W/m^2 K, and the right surface is subjected to heat flux at a uniform rate of 5000 W/m2.The nodal network of the problem consists of 15 equally spaced nodes with Δx= Δy= 1.2 cm, as shown in the figure. Obtain the finite difference equations at nodes 1, 2, 3, and 4,	**07**



OR

Q.5	**(a)**	Discuss the k-.ϵ Model of turbulence flow modeling.	**07**
	(b)	I) Explain validation of CFD models. ii) Explain the approximation and simplification of governing equations.	**07**

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