Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Examination July 2010

Subject code: 721005

Subject Name: Computational Fluid Dynamics

Date: 08 /07 /2010 **Time: 11.00am – 1.30pm**

Total Marks: 60

Instructions:

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

Q.1 **(a)** Discuss philosophy of CFD as – a tool for numerical experiments. **06**

(b) Derive the general energy conservation equation with stating assumptions. **06**

Q.2 **(a)** State important features of governing equations used as basis for problem formulation for fluid flow cases. **06**

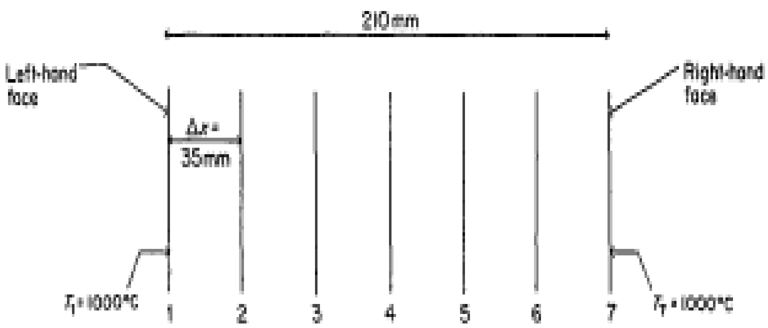
(b) Explain in detail Navier-Stokes equation and its important forms. **06**

OR

(b) Explain classification of quasi-linear partial differential equations. What is its importance associated with CFD? **06**

Q.3 **(a)** Discuss use of hyperbolic PDE in CFD for (i) steady inviscid supersonic flow, and (ii) unsteady inviscid flow. **06**

(b) Find out temperature distribution inside a steel slab, as shown in figure below, after five time steps. Initially slab is at 20 ºC and suddenly its faces are raised to 1000 ºC and maintained thereafter to 1000 ºC. Slab is having 210 mm thickness and dimensions perpendicular to thickness are very large. Steel has following properties k = 41 W/m-K, Cp = 504 J/ kg–K, ρ = 8000 kg /m^3. **06**



OR

Q.3 **(a)** Explain potential flow. What are assumptions to be made while writing potential flow equation? Discuss the merits and demerits of solving potential flow problem numerically. **06**

(b) Define vorticity and stream function. Write the differential form of vorticity – stream function equation. Derive integral form of the vorticity-stream function equation from differential form. **06**

Q.4	**(a)**	Find out temperature distribution inside a rectangular metal plate (sides in 1:2 proportions) as shown in figure 2 below. Inside conditions are not changing with respect to time. Refer boundary temperatures as shown in figure 3.	**06**

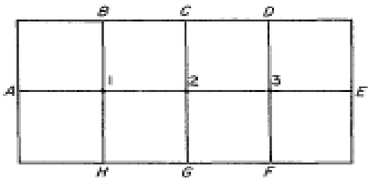


Figure 2.

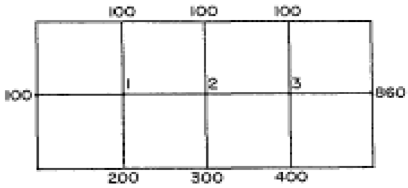
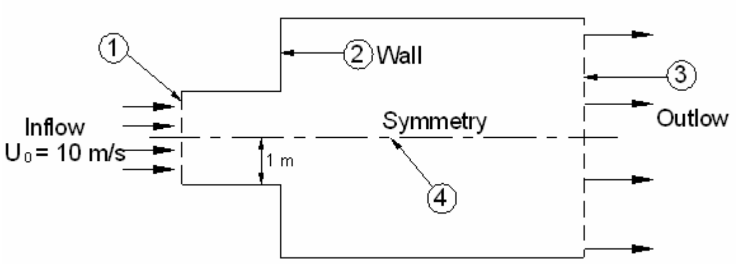


Figure 3.

	(b)	Discuss solution of Navier-Stokes equation using finite volume method with SMAC Algorithm.	**06**

OR

Q.4	**(a)**	The following fluid flow problem is symmetric so only half of the domain needs to be solved. Redraw the domain that need to be solved and apply boundary conditions for each of the boundaries (i.e. 1, 2 ,3 and 4) and state its meaning clearly. Consider the fluid flow variables as U, V and P.	**06**



	(b)	Using polynomial approach, derive one sided finite difference expression for a function $u(y) = a+by+cy^2$.	**06**
Q.5	**(a)**	Explain essential aspects of turbulent model used in CFD.	**06**
	(b)	Explain Reynolds Average Navier-Stokes (RANS) equation for modeling turbulent flow in fluid flow problem.	**06**

OR

Q.5	**(a)**	Discuss solution of steady boundary layer flow.	**06**
	(b)	How computational fluid dynamics techniques are different than traditional methods? What are its advantages?	**06**

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