Total No. of Questions : 10] **SEAT No. :**

P4936 **[Total No. of Pages :4**

[4959]-1055
B.E. (MECHANICAL SAND WICH)
Computational Fluid Dynamics
(2012 Pattern) (Semester - II) (Elective - I)

Time : 2.30 Hours] ***[Maximum Marks : 70***

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8. Q.9 or Q.10.***
2) ***Neat diagrams must be drawn wherever necessary. Figures to the right side indicate full marks.***
3) ***Use of electronic pocket calcultor is allowed.***
4) ***Assume suitable data, if necessary.***

Q1) a) Explain in detail the various flow models using an infinitesimal control volume. **[6]**

b) Write three fundamental physical principles upon which fluid dynamics is based on. **[4]**

OR

Q2) a) Explain any two possible errors in CFD analysis with examples. **[4]**

b) Write in detail with neat sketches **[6]**

i) hybrid grid

ii) multiblock grid

iii) body fitted grid

Explain the significance of each grid.

Q3) a) Derive the discretized form of the steady, one-dimensional, heat conduction equation and show that $k\frac{\partial^2 T}{\partial x^2}=0$ can be expressed as $\frac{T_{i+1}+T_{i-1}-2T_i}{(\Delta x)^2}=0$

Explain the order of accuracy of above equation. **[6]**

P.T.O.

b) Differentiate implicit methods over explicit methods. **[4]**

OR

Q4) a) Explain in detail Dirichlet and Neumann boundary conditions with examples. Draw neat sketches. **[4]**

b) Consider one dimensional steady-state heat conduction in rectangular horizontal.fin as shown in Fig. 1 The rectangular fin is subjected to the boundary conditions are shown in Fig. 1.

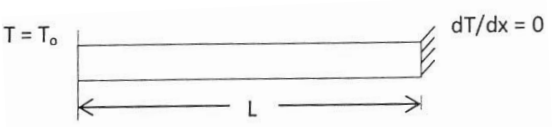

Fig.1 Rectangular fin

Above system results into following set of equations. Find the temperature distribution (temperatures, T_1 to T_4) in the fin using TDMA method.**[6]**

$$\begin{bmatrix} 2.25 & -1 & & \\ -1 & 2.25 & -1 & \\ & -1 & 2.25 & -1 \\ & & -2 & 2.25 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Q5) a) Show that for two dimensional convective-diffusive equation **[10]**

$$\frac{\partial \phi}{\partial t} + u\frac{\partial \phi}{\partial x} + v\frac{\partial \phi}{\partial y} = \vartheta\left[\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2}\right]$$

the CFL condition should be less than or equal to 0.5 for system to remain stable,

b) Explain Lax-Wendroff Method? Derive an expression for Lax Wendroff method and comment on the order of accuracy of the method. **[8]**

OR

Q6) a) Write first order wave equation. Discretize the wave equation with suitable numerical technique and find out the numerical solution at next time level. **[10]**

b) Derive and explain MacCormack's technique with predictor and corrector step. **[8]**

Q7) a) Explain the CFD simulation process for flow through pipe using SIMPLE numerical technique. Write stepwise algorithm to find out the numerical simulation using SIMPLE technique **[10]**

b) Write a short note on finite volume method. Comment on preference of finite volume method over finite difference method. **[6]**

OR

Q8) a) Explain the necessity of the variation of SIMPLER algorithm from SIMPLE algorithm. Explain how the drawbacks encountered in SIMPLE algorithm are overcome in SIMPLER algorithm. Write all the steps in the algorithm. **[10]**

b) Explain the need of relaxation techniques in numerical solution process. Write in brief about under-relaxation. **[6]**

Q9) a) In an automobile industry, it is recommended to use CFD tool for analysis of heat dissipation in brake disc as shown in Figure 2. Write in detail, methodology to do the CFD analysis of the brake disc including three distinct processes preprocessing, solver and post-processing. Comment on the **[10]**

i) objective of the grooves made on the disc and give suggestion on number of the groove and its pattern.

ii) method to reduce the computational time.

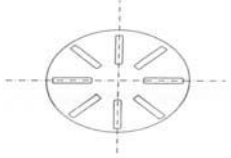

Fig.2 Brake disc

b) Explain in detail any two physical boundary conditions. Write in detail significance of physical boundary conditions in CFD analysis process. **[6]**

OR

Q10)a) CFD Post-processing is an important tool to study and analyze the fluid flow and heat transfer behavior. **[6]**

i) Write in detail the post-processing and its importance in CFD analysis process.

ii) Enlist the different tools in post processing in CFD to analyze the fluid flow and heat transfer.

b) A computational domain with different boundary conditions is shown in Figure 3.

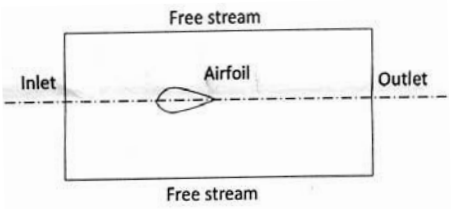

Fig.3 Computational Domain

Show with neat sketch where fine mesh is appropriately located. Explain in brief the importance of fine mesh in the domain. **[4]**

c) What is turbulence modeling? Explain k - ε model in detail. **[6]**

////