Total No. of Questions : 12]

SEAT No. :

P1193

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B.E. (Mechanical Sandwich)

b - COMPUTATIONAL FLUID DYNAMICS

(2008 Pattern) (Elective - II) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate answer books.***
2) ***Figures to the right side indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Use of Calculator is allowed.***
5) ***Assume Suitable data if necessary and mention it clearly.***

SECTION - I

Q1) a) Consider a 2D infinitesimally small control volume of size dx and dy. With neat diagram show all body and surface forces and derive the momentum equation in differential conservative form. **[10]**

b) Classify and identify the following PDEs **[6]**

i) $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$ ii) $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$ iii) $\frac{\partial^2 \phi}{\partial t^2} = a^2 \frac{\partial^2 \phi}{\partial x^2}$

OR

Q2) a) Explain the physical significance of divergence of velocity and Substantial derivative. **[8]**

b) Derive the equation for conservation of mass in differential form for infinitesimally small fluid element fixed in space. **[8]**

Q3) a) Discuss in detail explicit and implicit approaches for obtaining solution in CFD. Also discuss the advantages and disadvantages of these methods over each other. **[10]**

P.T.O.

b) Solve the system using Runge - Kutta method **[6]**

$\frac{dy}{dx} = x + y, \frac{dz}{dx} = x^2 - y^2$ subject to $x_0 = 0, y_0 = 1$ and $z_0 = 0.5$ to find y and z at 0.20 taking $h = 0.20$.

OR

Q4) a) Find the forward difference approximation of $O(\Delta x)$ for $\left(\frac{\partial^4 u}{\partial x^4}\right)$

Using both Taylor's series expansion and Backward difference formula. **[10]**

b) Explain : convergence and stability of numerical solution. **[6]**

Q5) a) Explain the followings: **[10]**

i) Crank Nicolson's scheme

ii) Artificial viscosity

b) Consider 4 × 4 tridiagonal matrix. Outline the procedure to solve using Thomas algorithm. Give one example where you will get a tridiagonal matrix. **[8]**

OR

Q6) a) Given function $f(x) = \cos(\pi x)$, find f' (0.25) using FDS and BDS of order $(\Delta x)^2$ and $(\Delta x)^4$. Use step size 0.01 and 0.1. **[10]**

b) Discuss the various types of boundary conditions with one example of each. **[8]**

SECTION - II

Q7) Consider the first order wave equation **[16]**

$$\frac{\partial u}{\partial t} + C\frac{\partial u}{\partial x} = 0$$

Write above equation in discretized form and obtain condition for stability of its numerical solution.

OR

Q8) Develop the solution algorithm for one dimensional transient heat conduction problem using **[16]**

a) Implicit scheme and

b) Explicit scheme

Q9) Consider inviscid Burger equation **[16]**

$$\frac{\partial u}{\partial t} + \frac{\partial f}{\partial x} = 0$$

Where $f = u^2 / 2$

Compute the solution for this equation for first step using Lax-Webdroff scheme with initial condition

$$u(x,0) = x^{0.5}, 0 \Leftarrow x \Leftarrow 1$$

OR

Q10) Write short note on: **[16]**

a) Finite volume method

b) Navier Stokes equations

Q11) a) Write down step by step procedure for SIMPLE algorithm. **[12]**

b) List the two types of errors encountered in numerical methods and indicate how the error occurs? **[6]**

OR

Q12) With suitable example explain CFD methodology by giving steps in a CFD simulation. Discuss the preprocessing, post processing, boundary conditions in detail. **[18]**

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