Registration No :

Total Number of Pages : 02

B.Tech
PME7D011

7th Semester Regular/Back Examination 2019-20
COMPUTATIONAL FLUID DYNAMICS
BRANCH : MECH
Max Marks : 100
Time : 3 Hours
Q.CODE : HRB362

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Only Short Answer Type Questions (Answer All-10) **(2 x 10)**

- **a)** Define convergence.
- **b)** Define discretization and round off error.
- **c)** What is the need for staggered grid?
- **d)** What types of grids are used in FVM?
- **e)** What are the important applications of CFD in engineering?
- **f)** What are the methods available for grid generation?
- **g)** Differentiate between structured and unstructured grid.
- **h)** Write down the significance of Taylor series expansion.
- **i)** Distinguish between conservation and non-conservation forms of fluid flow.
- **j)** Write down conservative form of continuity equation and explain the terms involved.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) **(6 x 8)**

- **a)** Write down elliptic, parabolic and hyperbolic partial differential equations as applicable to CFD.
- **b)** Write a short note on Explicit scheme and Crank-Nicolson scheme
- **c)** Describe Errors and uncertainty in CFD.
- **d)** Use finite volume method to divide total length of the rod into five equal control volumes and find the discritized equation for all internal node points.
- **e)** Derive the continuity equation in differential form for in compressible flow.
- **f)** List out differences between finite volume and finite difference methods.
- **g)** What are different basic rules that you need to obey to discretize any governing differential equation by finite volume method. Explain these clearly with supportive figures
- **h)** Draw a flow chart and describe SIMPLE algorithm for two-dimensional laminar steady flow equations in Cartesian co-ordinates.
- **i)** What is cell centered formulation? Explain with the use of control volume and semi discretization equation.
- **j)** Define peclet number and state its importance..
- **k)** State and explain the difference between explicit and implicit methods with suitable examples.
- **l)** Decribe the QUICK scheme approach.

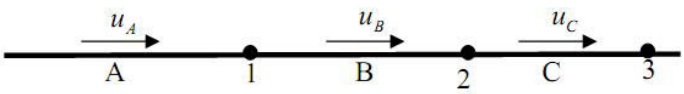
Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 In the one-dimensional constant-density situation below, the moementum equations for ub and uc can be written as follows: **(16)**

$$u_b = 5 + 2.5(p_1 - p_2)$$

$$u_c = 5 + 7.5(p_2 - p_3)$$



The boundary conditions are as ub=15, p3=10 (all values are given in consistent units).

i) Write the continuity equations for the regions AB and BC and hence derive the corresponding pressure correction equations.

Starting with guess for p1, p2, follow the SIMPLE procedure to obtain converged values of p2, ub ,uc.

Q4 The temperature variation in condenser tube is given by $\dot{m}C\dfrac{dT}{dx} = \dfrac{UA}{L}\left(T_0 - T\right)$, **(16)**

where $\dot{m}$ is the mass flow rate, C is the specific heat, T is the temperature of cooling water, T_0 is the constant temperature of the condensing steam, U is the overall heat transfer coefficient, A is the total heat transfer area. Define a non-dimensional temperature $\theta = \dfrac{T - T_{in}}{T_0 - T_{in}}$, $y = \dfrac{x}{L}$, Obtain θ as a function of y numerically, taking only 5 grid points using upwind scheme. Also compare with exact solution. You may take $\dfrac{AU}{\dot{m}C} = 2$.

Q5 Consider a cylindrical fin with uniform cross-sectional area A. the base is at a temperature of 120˚C (T_s) and the end is insulated. The fin is exposed to an ambient temperature of 25˚C. One-dimensional heat transfer in this situation is governed by d/dx{kA(dT/dx)}-hP(T-T_a) = 0 **(16)**

whereh_a is the convective heat transfer coefficient is the perimeter, k the thermal conductivity of the material and T_a the ambient temperature. Calculate the temperature distribution along the fin using five equally placed control volumes. Take hp / (kA)=25m^2

(note: kA is constant)

Q6 Derive the energy equation for a viscous flow in partial differential non-conservation form. **(16)**