B.E./B.TECH. Degree Examination, September 2020

Semester - VIII

CH16015 – COMPUTATIONAL FLUID DYNAMICS FOR CHEMICAL ENGINEERS

(Regulation 2016)

Time: Three hours | Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. Bernoulli's equation is applicable for
   A. laminar flow
   B. turbulent flow
   C. Both laminar and turbulent
   D. Inviscid flow
2. Representation of finite difference derivative is based on
   A. Newton's 2nd law
   B. Taylor series expansion
   C. Fredrick law
   D. Fourier series expansion
3. Which of these models will directly give the conservative equations suitable for the finite volume method?
   A. Finite control volume moving along with the flow
   B. Finite control volume fixed in space
   C. Infinitesimally small fluid element moving along with the flow
   D. Infinitesimally small fluid element fixed in space
4. Which of the following used to measure the stability of Finite Volume schemes?
   A. CFL condition
   B. Scarborough criterion
   C. Convergence test
   D. Richardson Grid convergence
5. State the reason why integral form of governing equations of fluid flow is considered fundamental than differential form?
6. Draw and show that the central difference is more accurate than forward difference?
7. Why Finite volume method is more suitable for solving fluid flow than finite difference method?
8. Why solving incompressible fluid flow will not limit flow field computation?

PART B - (4 X16 = 64 marks)

09. (a) Obtain the time rate of change of density of a moving fluid element with an example. Also state the necessary boundary conditions used? **(16)**

(OR)

(b) (i) Explain the definitions of turbulence kinetic energy (k) and rate of dissipation of turbulent kinetic energy (ε) for fluid flow and calculate for the fluid enters at 5m/s to a square duct of 2-inch in dimension. Assume relevant data with justification. **(10)**

(ii) Explain the boundary condition involved solving k – epsilon turbulence model equation. **(6)**

10. (a) Mention the equivalent finite difference expressions of following PDE and draw the modules using appropriate finite difference methods. **(16)**

$$\frac{\partial u}{\partial t}+\frac{u\partial u}{\partial x}+\frac{v\partial u}{\partial y}+\frac{w\partial u}{\partial z}=-\frac{1}{\rho}\frac{\partial P}{\partial x}+\gamma\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)$$

(OR)

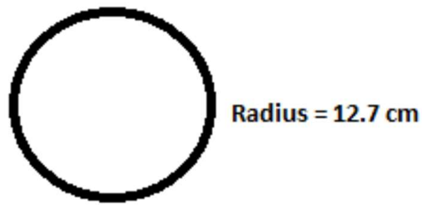
(b) Explain the explicit and implicit approaches of the following two dimensional heat conduction equation. **(16)**

$$\frac{\partial T}{\partial t} = \alpha \left\{ \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} \right\}$$

11. (a) Give practical example and reduce the one dimensional diffusion equation with heat source into discretized form of equation. **(16)**

(OR)

(b) Consider steady state laminar fluid flow through a circular pipe of constant cross section as shown in the figure below. Develop the system of discretized equation with the minimum 4 nodes inside the pipe using Finite volume approach; Assume the relevant data with justification. **(16)**



At solid boundaries u,v,w = 0 (No - slip condition)

Note: Velocity components applicable to the problem are u =0, v =0, and w ≠ 0, and w = f (r), the maximum velocity at center is 10 m/s.

12. (a) Apply the principles of finite volume method and derive the pressure correction equation for one dimensional laminar steady fluid flow. Assume necessary properties if applicable. **(16)**

(OR)

(b) Prepare a flow sheet to describe the solution mechanism by SIMPLE method for an one dimensional laminar steady fluid flow. **(16)**