Total pages:2

PG CBCS

M.SC. Semester-II Examination, 2021

(MATHEMATICS)

PAPER: MTM-201

(FLUID MECHANICS)

Full Marks: 40 **Time: 2 Hours**

Answer any FOUR questions from the following: **4×10=40**

1. Using matrix method determine the stability criteria for FTCS scheme and general two-level scheme. 10

2. (a) What do you mean by analytical/exact solution of Navier-Stokes equation?
   (b) With the necessary assumptions, find the exact solution for the case of Poisseuille flow.
   (c) Show the velocity profile graphically for the above Poisseuille flow for different values of pressure gradient. 2+6+2

3. Derive the non-conservative form of energy equation. 10

4. (a)What is Newtonian and Non-Newtonian fluid? Discuss with examples.
   (b) Derive the expression for substantial derivative in cartesian coordinate systems for the y-velocity component by (i) considering the infinitesimally small fluid element moving in space, and (ii) using the chain rule. Discuss the similarity/dissimilarity among these two derivations. Also discuss the physical significance of substantial derivative. 4+6

5. (a) Derive the relation between local derivative and substantial derivative for an infinitesimally small fluid element moving with the flow.
   (b) Derive the equation of continuity for a fluid within a finite control volume fixed in a space.
   C. Discuss the physical significance of divergence of velocity. 4+4+2

6. (a) Based on the observations of Ludwig Prandtl for boundary layer theory, derive the set of governing equations for the boundary layer flow along a flat plate.
   (b) Write the proper boundary conditions for the above set of equations.
   (c) Write the physical principals used for the equations of continuity, Navier-Stokes and energy. 6+2+2

7. (a) What are the differences between steady flow and unsteady flow?
   (b) What are the differences between laminar flow and turbulence flow?
   (c) Let the velocity component of a liquid is given by $u = \frac{x}{2+t}, v = 2y, w = 0$. Determine streamline equation of flow. 3+3+4

8. (a) Arrange the velocities (x- and y-components) and pressure in the Staggered Gird and then write the advantage – disadvantage of this arrangement.
   (b) How many types of time integration methods possible? Write advantage/disadvantage of any two?
   (c) Draw the schematic of the finite difference solution process.
   3+4+3

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