Total page: 02

PG CBCS

M.Sc. Semester-II Examination, 2022

(Mathematics)

PAPER: MTM 201

(FLUID MECHANICS)

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

The figures in the right-hand margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer any four questions: **4×2=8**

a) Show that the central difference approximation produces a higher order truncation error than forward difference approximation.

b) What is the effect of Reynold number for determining the relative boundary layer thickness?

c) What is viscosity? Discuss the difference between Newtonian fluid and non-Newtonian fluid.

d) Define similar flow and Reynond Number.

e) Draw an infinitesimally small moving element and show all energy fluxes along y-direction associated with the above element.

f) How many types of variable arrangement are in the Computational Fluid Dynamics? Discuss them by arranging the x- and y-components of velocities and pressure.

2. Answer any four questions: **4×4=16**

a) Using Taylor series expansion, derive the truncation error for the time and spatial derivative.

b) What is boundary layer? Discuss the relation of boundary layer thickness with Reynold number.

c) Derive the Hagen-Poiseuille equation for a laminar flow through a pipe.

d) What is Couetee flow? Discuss the nature of the Couetee flow between two parallel plates for different pressure gradient.

e) An incompressible velocity fields is given by $u = a(x^2 - y^2)$, $v = -2axy$ and $w = 0$. Determine under what conditions it is a solution to the Navier-Stokes momentum equation for the case of without any body forces. Assuming that these conditions are met, determine the resulting pressure distribution.

[P.T.O]

f) Discretize the one dimensional transport equation $\frac{\partial T}{\partial t} + a\frac{\partial T}{\partial x} = \alpha\frac{\partial^2 T}{\partial t^2}$ where a and α are constants, using Crank-Nicolson scheme and hence write the algebraic expression in a matrix form for the case of Neumann boundary conditions.

3. Answer any <u>two</u> questions: **2×8=16**

a) Derive the Navier-Stokes equation in conservative form.

b) Derive the Blasius's equation for a boundary layer of a fluid flow along a flat plate.

c) (i) An incompressible velocity fields is given by $u = 2(x^3 - 2xz), v = c$ and w is unknown, where c is any constant. What must be the form of velocity component w be?

(ii) Write the algebraic formula for $\frac{dy}{dx}$ using forward, backward, central, and three points asymmetry for forward as well as backward schemes. Also write the order of accuracy of these schemes. [4+4]

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