

**MA/ MSCMT-07**

December - Examination 2019

**M.A./M.Sc. (Final) Mathematics Examination****Viscous Fluid Dynamics****Paper - MA/ MSCMT-07****Time : 3 Hours ]****[ Max. Marks :- 80**

**Note:** The question paper is divided into three sections A, B and C. Write answers as per given instructions.

**Section - A****8 × 2 = 16**

(Very Short Answer Type Questions)

**Note:** Answer **all** questions. As per the nature of the question delimit your answer in one word, one sentence or maximum upto 30 words. Each question carries 2 marks.

- 1) (i) Write the equation of continuity in vector form.
- (ii) Define unsteady motion.
- (iii) Define Himenz Flow.
- (iv) What do you mean by critical Reynolds number?
- (v) What do you mean by dynamical similarity?
- (vi) Write down equation of energy of a viscous incompressible fluid in spherical polar coordinates.
- (vii) What is the Eckert number for gases in high speed flow?
- (viii) State the Reynold's law.

## Section - B

 $4 \times 8 = 32$ 

(Short Answer Type Questions)

**Note:** Answer **any four** questions. Each answer should not exceed 200 words. Each question carries 8 marks.

2) The stress tensor at a point P is:

$$\sigma_{ij} = \begin{bmatrix} 7 & 0 & -2 \\ 0 & 5 & 0 \\ 2 & 0 & 4 \end{bmatrix}$$

Determine the stress vector on the plane at P whose unit normal is

$$\hat{n} = \frac{2\hat{i}}{3} - \frac{2}{3}\hat{j} + \frac{1\hat{k}}{3}$$

- 3) Explain back flow in case of generalized coquette flow.
- 4) Discuss coefficient of skin friction when flow is in a circular pipe.
- 5) Discuss flow between two parallel porous plates.
- 6) What is the physical importance of non-dimension parameters? Discuss the Froude number.
- 7) A 1:20 model of an air duct is to be tested in water which is 45 times more viscous and 850 times denser than air. What should be the pressure drop in the prototype if the pressure drop is  $3\text{kg}/\text{cm}^2$  in the model when tested under hydro dynamically similar conditions?
- 8) Discuss coefficient of skin friction when flow is in a circular pipe.
- 9) Write a short note on Thermal Boundary layer.

## Section - C

 $2 \times 16 = 32$ 

(Long Answer Type Questions)

**Note:** Answer **any two** questions. You have to delimit your each answer maximum upto 500 words. Each question carries 16 marks. Use of non-programmable scientific calculator is allowed in this paper.

10) Write short note on following:

- (a) Eckert Number
- (b) Grashoff Number
- (c) Pe'clet Number
- (d) Brinkman Number

11) Discuss Oseen's flow past a sphere.

12) (i) Show that the volume rate of flow is given by  $Q = \frac{27Pa^4}{20\sqrt{3}\mu}$  in

the steady flow of a viscous incompressible fluid through a tube with uniform equilateral triangular cross section.

(ii) State and prove Buckingham  $\pi$ - theorem.

13) Obtain Navier-stokes equation of motion in Cartesian coordinates for two dimensional incompressible viscous flow.

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