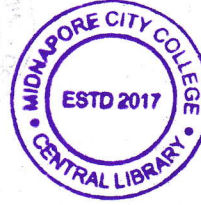


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PG (CBCS)  
M.Sc Semester- II Examination, 2023  
MATHEMATICS  
PAPER: MTM 201  
(FLUID MECHANICS)



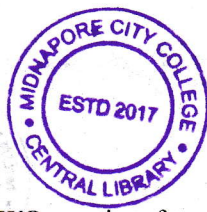
Full Marks: 50

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 from the following: 4×2=08
  - a) What are the importances of Reynold number in fluid mechanics?
  - b) Write down the process of non dimensionalization to a differential equation.
  - c) Find the substantial derivative of the steady state velocity field represented by the velocity vector  $\vec{V} = (-3x, -3y, 6z)$ .
  - d) Find the thickness of the boundary layer for a incompressible viscous flow over a flat plate of length 10meter at which the Reynold number is  $10^4$ .
  - e) Write the z-component of Reynolds Averaged Navier-Stokes (RANS) equations.
  - f) Define Reynold stress.
  
2. Answer any **FOUR** questions from the following: 4×4=16
  - a) Discuss the separation of a boundary layer from an obstacle with its velocity profile.
  - b) Derive the Hagen-Poiseuille equation for a laminar flow through a pipe.
  - c) Discuss the continuity equation for a flow field considering the infinitesimal small fluid element moving with the flow.
  - d) For the Poiseuille flow in a channel, write the necessary assumptions, deduce the approximate equation, draw the flow configuration and write the required boundary condition on the configuration. Also write the complete set of Navier-Stokes equation for a channel laminar incompressible viscous flow, draw the flow configuration and show the boundary conditions at the inlet, outlet and channel walls. Finally show the velocity profile graphically for the Couette - Poiseuille flow for positive and negative pressure gradients.
  - e) Draw an infinitesimally small moving element and show all the surface forces acting along the y-direction on the element. Finally find the net surface and body forces acting on that element.
  - f) 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)



(2)

3. Answer any **TWO** questions from the following:

2×8=16

- a) Derive the Energy equation in non-conservative form for the infinitesimal small fluid element moving with the flow.
- b) Derive the Blasius's equation for a boundary layer of a fluid flow along a flat plate.
- c) Show that the similarity solution of the boundary layer equations are obtained when the velocity distribution of the potential flow is proportional to a power of the length of arc measured along the wall from the stagnation point.
- d) 2+6
  - i) Write all the equations of motion in terms of eddy viscosities.
  - ii) For the ocean with horizontal and vertical length scales 1000 KM and 2KM, respectively and horizontal speed of order 0.15m/s, scale all the above equations written in part-(a) and reduces to approximated equations with order of accuracy 1%.

[Internal Assessment- 10 Marks]

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