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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 Poisseuille 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 - Poisseuille 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)

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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