Ref. No.: Ex/ME(M2)/PC/B/T/213/2023(S)

B.E. MECHANICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2023

Subject: FLUID MECHANICS - II **Time: 3 Hrs.** **Full Marks: 100**

Answer any five questions. Write all pertinent assumptions. Assume any missing data and symbol.

1. (a) Explain fully developed flow through parallel plates with the help of neat sketch?

   (b) For a viscous incompressible flow due to pressure difference through two flat stationary plates having infinite expanse, deduce the expression for the velocity profile, maximum and average velocity, and discharge per unit width. Write the appropriate assumptions. **(5+15)**

2. (a) Starting from the governing equation for 2D incompressible laminar boundary layer, obtain the *Momentum Integral equation.*

   (b) With suitable examples, discuss the different types of drag force. **(15+5)**

3. (a) Lubricating oil of specific gravity 0.82 and dynamic viscosity 12.066×10^{-2} Pa.s is pumped at a rate of 0.02 m^3/s through a 0.15 m diameter 300 m long pipe. Calculate the pressure drop, average shear stress at the wall and power required to maintained the flow if the pipe is horizontal.

   (b) The velocity profile for a flow of air over a flat plate is approximated as, $u/U_0 = a_1(y/\delta) + a_2(y/\delta)^2$. The free stream velocity (U_0) of air is 10 *m/s* and its kinematic viscosity is $1x10^{-5} m^2/s$. Find the wall shear stress in terms of boundary layer thickness δ. Also find the ratio of boundary layer thickness with the length x in the direction of flow in terms of Reynolds number. **(10+10)**

4. An ideal flow is composed of a doublet and a uniform flow. Develop the equation of the resultant streamlines and show that this flow can be thought of as a flow past a circular body. Hence, deduce the net force exerted by the fluid on the circular body. Show the pressure distribution over the body. **(20)**

5. (a) Consider isentropic flow occurring from a reservoir through a converging nozzle. Find the condition for maximum mass flow rate. Obtain the value of the ratio of exit pressure at the nozzle with stagnation pressure at the reservoir at that condition. Show the typical variation of mass flow rate with this pressure ratio.

   (b) Distinguish between zone of silence and zone of action in the context of compressible flow. **(15+5)**

6. A small sphere of density ρ_s and diameter D settles at a terminal velocity V in a liquid of density ρ_f and dynamic viscosity μ. Gravity g is known to be a parameter. Using the Buckingham's π-theorem, express the functional relationships between these variables in a dimensional form. **(20)**

7. Write short notes on: (a) Vortex shedding behind a circular cylinder (b) Order of magnitude analysis (c) Kutta-Joukowski's law (d) Lift and drag. **(5+5+5+5)**