Ref. No. : Ex/ME/5/T/113/2024

BACHELOR OF ENGINEERING (MECH. ENGG.) 1ST YR 1ST SEMESTER EXAM 2024

FLUID MECHANICS – II

Time: Three Hours **Full Marks: 100**

STRICTLY FOLLOW THE INSTRUCTIONS GIVEN BELOW.

Symbols in the question paper carry their usual meanings. However, the symbols you will use during answering should be named with the used units

Assume any relevant data if necessary with suitable justifications.

*Answer any **FIVE** Questions.*

***All the parts of a question** must be **answered TOGETHER**.*

1. State all assumptions, draw a clear FBD diagram, and derive the velocity profile and pressure drop through a circular pipe. **[20]**

2. (a) Write assumptions and find the expression of a velocity profile for steady flow between two parallel plates when the top plate is moving at a constant velocity U_o.

   (b) The lubricating oil of specific gravity 0.82 and dynamic viscosity 12.066×10^{-2} Pa.s is pumped at a rate of 0.01 m^3/s through a 0.15 m diameter and 500 m long pipe. Calculate the Reynolds number, pressure drop, average shear stress at the wall, and power required to maintain the flow. **[10+10]**

3. (a) Explain how the boundary layer grows over a flat plate and mention all flow regimes including the laminar sub-layer.

   (b) Using scale analysis, formulate Prandtl's boundary layer equations over a flat plate. **[10+10]**

4. Derive von Karman momentum integral equation (MIE) for boundary layer flow. **[20]**

5. (a) With the neat sketches, explain the nominal, displacement, and momentum thicknesses with their mathematical expressions.

   (b) Using the von Karman momentum integral equation, find the expressions for wall shear stress, displacement, and momentum thicknesses for a linear velocity profile. **[10+10]**

6. (a) Discuss in details the stream function (ψ) and velocity potential function (ϕ) for free vortex flow.

   (b) Using the method of superposition, find equations of ψ and component velocities for an ideal flow consisting of a pair of equal-strength source and sink flow and doublet flow. **[7+13]**

7. (a) Find the speed of sound wave through a compressible fluid under the adiabatic condition.

   (b) Explain three types of expansion processes in a convergent-divergent nozzle flow. **[10+10]**

8. Write short notes on the following (ANY FOUR). **[5×4 = 20]**

   i) Water Hammer
   ii) Source flow
   iii) Friction factor f = 64/Re
   iv) Magnus effects
   v) Von Karman vortex street
   vi) Types of compressible flow