BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
FIFTH YEAR

SECOND SEMESTER EXAM 2024

Ref. No.: Ex/ME/5/T/524C/2024

INTRODUCTION TO TURBULENCE

Time:-Three Hours Full Marks:-100

Answer any **five** Questions

Assume any data relevant to the questions if not provided

1. Write the differences of Laminar and Turbulent Flows with an example of each of the flow. What is the nature of transitional flow? What is critical Reynolds number? What is the importance of critical Reynolds number (both upper and lower) for a pipe flow? (20)

2. Explain in details the characteristics of the turbulent flow. (20)

3. (a) Draw a boundary layer over a flat plate showing the laminar, transitional and turbulent zones along with laminar sublayer. (10)

   (b) Explain Bousinesq's theory of turbulence. (10)

4. With neat diagrams explain the origin of turbulence. (20)

5. a) What do you understand by large eddies and small eddies? What is energy cascading. (10)

b) Explain isotropic and an-isotropic turbulence. (10)

6. Show that both mean velocities ($\overline{U}, \overline{V}$ and $\overline{W}$) as well as fluctuating components (u', v' and w') follow continuity equation. (20)

7. Derive the Reynolds averaged Navier-Stokes equation for an incompressible unsteady turbulent 3-D flow in rectangular co-ordinate system. (20)

8. Explain Prandtl's Mixing Length theory for a 2-D incompressible and steady Turbulent flow and obtain the expression for the Mixing Length. (20)

9. Write short note on any two. (2 x 10 =20)

a) Reynolds Stresses

b) Energy cascading

c) Wall Function in $k-\varepsilon$ model.

d) Explain Hydro-dynamically smooth and rough boundaries.