BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
FIFTH YEAR
SECOND SEMESTER EXAM 2023

Ref. No.: Ex/ME/5/T/524C/2023

INTRODUCTION TO TURBULENCE

Time:-Three Hours   Full Marks:-100

Answer any **five** Questions

Assume any data relevant to the questions if not provided

1. a) Define Laminar and Turbulent Flow with an example of each of the flows. What is a transitional flow? What are the critical Reynolds number (both upper and lower) of pipe flow and flow over a boundary layer?

(10)

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

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

3. a) What do you understand by large eddies and small eddies? Why large eddies are called energy producing eddies?   (10)

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

4. a) With neat diagrams explain the origin of turbulence.   (15)

   b) Show that vortex superimposed on mean flow generates the fluctuating components u', v' in a turbulent flow.   (05)

5.   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)

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

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

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

a) Reynolds Stresses

b) Energy cascading

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