

**B. E. MECHANICAL ENGINEERING FOURTH YEAR FIRST SEMESTER EXAM
2025**

Ref. No. : Ex/ME(M2)/PE/H/T/414G/2025

INTRODUCTION TO TURBULENT FLUID FLOW (HONS.)

Time:-Three Hours

Full Marks:-100

Answer any **five** Questions

Assume any data relevant to the questions if not provided

1. a) Define a turbulent flow, intensity of turbulence and turbulent viscosity. (09)
b) Explain the origins of turbulence. (06)
c) Why the large eddies are called energy producing eddies? (05)
2. Explain in details the characteristics of turbulent flow. (20)
3. a) Explain hydraulically smooth and rough boundaries. (08)
b) Deduce the velocity distribution for turbulent flow in smooth pipes as:
$$\frac{u}{u_f} = 5.75 \log_{10} \left[\frac{u_f \cdot y}{\nu} \right] + 5.5$$

Where the symbols have their usual meanings. (12)
4. a) Explain the Boussinesq's and Reynolds theories. (06)
b) What is **Vortex Stretching**? Explain in details and give an example. (14)
5. a) Show that both the average and fluctuating velocities follow continuity equation. (10)
b) Show analytically that Turbulent Flow is always **three dimensional (3-D)**. (10)

[Turn over

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 Four. (4 x 5 =20)

- a) Auto Correlation
- b) Length, time and velocity scales.
- c) Isotropic and An-isotropic Turbulence
- c) Reynolds Stresses
- d) Laminar Sublayer
- e) Wall Function in $k - \varepsilon$ model.