B. MECH ENGG. FINAL YEAR, 2ND SEMESTER EXAMINATION 2019

INTRODUCTION TO TURBULENCE

Time: Three hours   Full Marks: 100

Answer any five (5) questions.
Answer to all parts of a particular question must be together.

1. a) What do you mean by critical Reynolds number explain with example.
   b) Describe main features of turbulence
   c) Estimate the Reynolds number for Kolmogorov scale eddies. Derive the smallest length and velocity scale in the flow field produced by a mixer which can contain 2 Kg of water and requires 500 W. Take kinematic viscosity value as 10^{-6} m^2/s   2+8+10

2. a) What is Kurtosis? Find out the Kurtosis value for Gaussian distribution.
   b) Derive the Reynolds averaged continuity equation
   c) Write the expression for turbulent heat flux term and explain turbulent Prandtl number in this context.   12+4+4

3. a) Explain turbulent stress - write the terms of turbulent stress for three dimensional flow. How it is connected to turbulent viscosity?
   b) Temperature and velocity values at 10 intervals were found to be (10.9, 10.7,10.6,10.2,10.1,10,9.8,9.6,9.5,9.4,9.2) and (0.1,0.2,0,3,0.4,0.5,0.6,0.7,.0.8. 0.9, 1.0,1.1) Find out the value of $\overline{T'^2}$ and u$_{rms}$ and TKE

                                                                            8+12

4. a) State three hypotheses of Kolmogorov.
   b) Sketch and explain energy spectrum due Kolmogorov.
   c) Assuming the energy level E(k) of a wave number depends on wave number and dissipation rate, establish the -5/3 slope relation.

                                                                            6+10+4

5. a) Discuss the turbulent boundary layer over a flat plate with appropriate expressions for velocity profiles
   b) For 1/7th power law profile of velocity show that u$_{av}$/ u$_{max}$ = 0.8

                                                                            12+8

                                                                    [Turn over

6. a) Water flows through a tube with diameter of 25 mm. At a location of 3m from inlet, water velocity is 3 m/s and the temperature is 280 ^{0} C. The surface temperature is 250^0 C. Estimate the local heat transfer coefficient at this location and rate of heat transfer.

   The thermo-physical properties is SI units are μ =9.356 x 10^{-4}, C_P = 5278, K = 0.5803

   b)   Define Eularian auto-correlation coefficient. Sketch the distribution of fluctuating   u and v components for positive, negative and zero value of the coefficient.

   c) A data set reads [2,5,-1,3,4,5,0,2]. Find out the skewness coefficient of the data and state the direction in which the distribution is skewed.

                                                                         8+6+6

7. a) Briefly outline the procedures for simulating turbulent flow in different ways. In this context explain the k- Ɛ model with its advantages and limitations.

   b) Explain turbulent kinetic energy budget and state the procedures to derive it.

                                                                         (6+6)+8