

BENGAL ENGINEERING & SCIENCE UNIVERSITY, SHIBPUR
M.E., 1st Semester Examination, December 2011
FLUID TURBULENCE – I (AM 910)

Full Marks 70

Time – 3 hours

Answer any five questions

Each question carries equal mark

1. Derive the time averaged Reynolds equation for turbulent flow?
2. Derive the time averaged energy equation as applied to turbulent flow?
3. At a given point in the turbulent flow field, the instantaneous values of u and v velocity components measured at an interval of 0.025 seconds are given below. Determine, mean u and v velocity, turbulence intensities, Reynolds stress, and turbulence kinetic energy.

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14
u (m/s)	7.93	3.69	4.21	4.30	5.37	2.62	4.85	4.97	8.54	7.50	7.72	2.87	8.75	4.15
w	0.18	0.74	2.05	0.55	0.90	1.49	0.16	0.52	0.52	1.23	0.98	2.23	1.38	0.57

4. (a) A smooth pipe carries $0.30\text{m}^3/\text{s}$ of water discharge with a head loss of 3.0 m per 199m length of pipe. If the water temperature is 20°C , determine the diameter of the pipe.
(b) In a 0.5m diameter rough pipe carrying water at 20°C , the velocity and velocity gradient at 50mm from the wall are 4.42m/s and 0.005523 /s, respectively. Determine the water discharge, roughness height, friction factor, wall shear and pressure gradient.
5. Define stationary and non-stationary process. Explain these two processes with application to turbulent flow. What is correlation function? Explain in detail the application of correlation function in turbulent flow. Explain Prandtl's mixing length theory. Explain how turbulence can be useful for engineering practice?
6. Explain the principle of Von Karman similarity. What is velocity spectrum? Explain its significance with relevance to turbulent flow. What is eddy viscosity? What do you mean by time scale and length scale of turbulence? Explain the Kolmogorov scale of turbulence.
7. Explain how momentum transport occurs in a turbulent flow. Explain the working principle of a Hot Wire Anemometer.
8. Derive the equation for shear stress distribution in open channel turbulent flow, based on Reynolds equation for steady, uniform, zero pressure gradient, two dimensional flow. Explain the working principle of particle image velocimetry.
9. What do you mean by intrusive and non-intrusive method of fluid flow measurement and state the measurement principle of two instruments in each category? What do you mean by instrument calibration? How is the distinction between a smooth bed flow and rough bed flow made? Explain the working principle of Laser Doppler Velocimeter.