

Introduction to Turbulent Flow

Q1. Choose the correct answer

- (i) $\frac{\partial u'}{\partial x} + \frac{\partial v'}{\partial x} = 0$ for a turbulent flow signifies
- (a) conservation bulk momentum transport
 - (b) increase in u' in the positive x direction will be followed by increase in v' in negative y direction
 - (c) turbulence is isotropic
 - (d) turbulence is anisotropic

[Ans.(b)]

- (ii) Prandtl's mixing length at the wall of a pipe is
- (a) 1
 - (b) 0
 - (c) a function of Reynolds number of flow
 - (d) a function of wall shear stress at the wall

[Ans.(b)]

- (iii) A turbulent boundary is thought to be comprising a laminar sublayer, a buffer layer and a turbulent zone. The velocity profile outside the laminar sublayer is described by a
- (a) linear profile
 - (b) parabolic profile
 - (c) cubic profile
 - (d) logarithmic profile

[Ans.(d)]

Q2.

In an experiment on turbulent flow, following velocity data were recorded at 1 s interval at a point

u (cm/s)	15	27	33	-3	9	21
v (cm/s)	4	-5	-3	12	7	9

Find $\overline{u'v'}$.

Solution

Average value of u is given by

$$\bar{u} = \frac{15 + 27 + 33 - 3 + 9 + 21}{6} = 17 \text{ cm/s}$$

Average value of v is given by

$$\bar{v} = \frac{4 - 5 - 5 + 12 + 7 + 9}{6} = 4 \text{ cm/s}$$

The fluctuating components are found to be

$$u' = u - \bar{u}$$

$$v' = v - \bar{v}$$

The fluctuating components of velocities are listed below:

u' (cm/s)	-2	10	16	-20	-8	4
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v' (cm/s)	0	-9	-7	8	3	5
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The average of the product of the fluctuating components of velocities is computed as

$$\overline{u'v'} = \frac{0 - 90 - 112 - 160 - 24 + 20}{6} = -61$$