Problems on Chapter 7: Friction and Eddy Viscosity

Q 7.1: Show that if an overbar ($\overline{x}$) represents a time mean, and a dash (x') represents a departure therefrom, that for general quantities s , r in a flow which is steady (or for which the time mean varies so slowly that changes in the time-mean can be neglected) that

$\overline{(s')}=0$,

$\overline{\overline{s}}=\overline{s}$,

and hence that

$\overline{s \cdot r}=\overline{s} \cdot \overline{r}+\overline{s' \cdot r'}$.

Q 7.2: Suppose $u=u_0(4+\cos(ht+\varepsilon))$ **and** $w=w_0(1+\cos(ht))$ **, with** $u_0=3\,\mathrm{ms}^{-1}$ **and** $w_0=0.5\,\mathrm{ms}^{-1}$ **and assume** $\rho=1.2\,\mathrm{kg\,m}^{-3}$ **. Sketch the instantaneous value of** $u'w'$ **and calculate the mean and eddy contributions to the flux of momentum for**

(a) $\varepsilon=0$,

(b) $\varepsilon=\pi/4$,

(c) $\varepsilon=\pi/2$,

(d) $\varepsilon=3\pi/4$.

Q 7.3: If $\overline{u}$ **has the value of 8 ms^{-1} at a height of 2 m and 10 ms^{-1} at a height of 3 m, estimate the vertical flux of x-momentum for an occasion on which** K **was 4 m^{2}s^{-1}.**