宿題(2)(提出日:11月29日)

[1]

$$\begin{split} &\frac{\tau}{\tau_w} = \frac{r}{R} = (1 - \frac{y}{R}) \\ &\tau = \rho l^2 (\frac{du}{dy})^2 = \tau_w (1 - \frac{y}{R}) \\ &l = \frac{u^* \sqrt{1 - y/R}}{du/dy} \\ &\frac{u}{U} = (\frac{y}{R})^{1/7}; \quad \frac{du}{dy} = \frac{U}{R} \frac{1}{7} (\frac{y}{R})^{-6/7} \\ &\frac{l}{R} = \frac{u^*}{U} 7 (\frac{y}{R})^{6/7} \sqrt{1 - y/R} \end{split}$$

$$\begin{split} &\frac{u}{V} = \sin\frac{\pi}{2}\frac{y}{\delta}, \quad \frac{y}{\delta} = \eta, \quad dy = \delta d\eta \\ &\delta^* = \int_0^\delta (1 - \sin\frac{\pi}{2}\frac{y}{\delta}) dy = \delta \int_0^1 (1 - \sin\frac{\pi}{2}\eta) d\eta \\ &= \delta(\eta + \frac{2}{\pi}cos\eta) \mid_0^1 = \delta(1 + 0 - 0 - \frac{2}{\pi}) = 0.363\delta \\ &\theta = \delta \int_0^1 \sin\frac{\pi}{2}\eta (1 - \sin\frac{\pi}{2}\eta) d\eta \\ &= \delta - \frac{2}{\pi}cos\eta - \frac{1}{\pi}(\frac{\pi}{2} - \sin\frac{\pi}{2}cos\frac{\pi}{2}) \mid_0^1 = \delta(\frac{2}{\pi} - \frac{1}{2}) = 0.137\delta \\ &H = \frac{\delta^*}{\theta} = 2.65 \end{split}$$

$$\begin{split} &\frac{v}{V} = \frac{3}{2}\eta - \frac{1}{2}\eta^3, \quad \frac{y}{\delta} = \eta, \quad dy = \delta d\eta \\ &\delta^* = \int_0^\delta (1 - \frac{v}{V}) dy = \delta \int_0^1 (1 - \frac{3}{2}\eta - \frac{1}{2}\eta^3) d\eta = \frac{3}{8}\delta = 0.375\delta \\ &\theta = \delta \int_0^1 (1 - \frac{3}{2}\eta - \frac{1}{2}\eta^3) (\frac{3}{2}\eta - \frac{1}{2}\eta^3) d\eta = 0.139\delta \\ &H = \frac{\delta^*}{\theta} = 2.69 \end{split}$$