ME-318 Engineering Heat Transfer

Chapter 7
Important Concepts & Equations

- Thermal Boundary Layer Thickness, Laminar flow:

$$\frac{\delta}{\delta_T} \approx \mathrm{Pr}^{1/3}$$

- Laminar Local and Average Nusselt Numbers:

$$Nu(x) = \frac{hx}{k_f} = 0.332\ (\mathrm{Re}_x)^{1/2}(\mathrm{Pr})^{1/3}$$

$\mathrm{Pr} \geq 0.6$

$$\overline{Nu}_L = \frac{\bar{h}\ L}{k_f} = 0.664\ (\mathrm{Re}_L)^{1/2}(\mathrm{Pr})^{1/3}$$

$$\overline{Nu}_L = 2Nu(x)$$

- Turbulent Boundary Layers:

$$\frac{\delta}{\delta_T} \approx 1$$

$$Nu(x) = 0.0296\ (\mathrm{Re}_x)^{4/5}(\mathrm{Pr})^{1/3} \qquad 0.6 \leq \mathrm{Pr} \leq 60$$

Turbulent over entire plate

$$\overline{Nu}_L = 0.037\ \mathrm{Re}_L^{4/5}\ \mathrm{Pr}^{1/3}$$

Mixed Flow

$$\overline{Nu}_L = \left(0.037\ \mathrm{Re}_L^{4/5} - 871\right)\mathrm{Pr}^{1/3}$$

- Cross Flow Over Cylindrical Tube:

$$\overline{Nu}_L = \frac{\bar{h}\ D}{k_f} = 0.3 + \frac{0.62(\mathrm{Re}_D)^{1/2}\ \mathrm{Pr}^{1/3}}{\left[1 + (0.4/\mathrm{Pr})^{2/3}\right]^{1/4}}\left[1 + \left(\frac{\mathrm{Re}_D}{282{,}000}\right)^{5/8}\right]^{4/5}$$