Plate Drag, Turbulence

3.044 March 30, 2005

Mechanics:

- Problem Set 5 due next Monday
- Freshman Open House tomorrow 11:30-1:30, Chipman
- ACP talk on research activities Friday noon, Chipman

Today's lecture:

- Friction factor and drag on a flat plate
- Turbulence!

Test 1 Averages

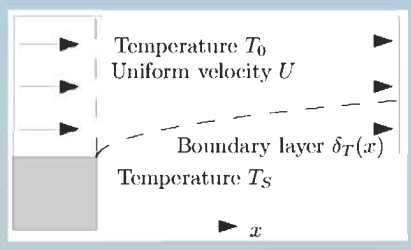
In-class: Mean 56.44, std dev 12.87, max 89 (!)

Corrected: Mean 94.47, std dev 5.80, max 100

Average: Mean 75.45, std dev 8.32, max 94

Boundary Layers

Conduction in moving solid



Steady-state, $\delta_T << x$

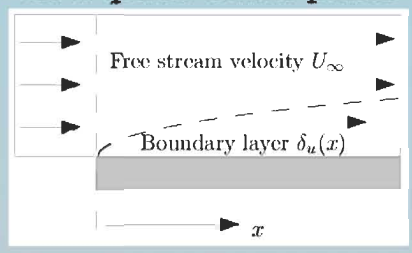
$$u_x \frac{\partial T}{\partial x} = \alpha \frac{\partial^2 T}{\partial y^2}$$

$$T = A + B\text{erf}\left(\frac{y}{2\sqrt{\alpha x/U_\infty}}\right)$$

1% BL profile:

$$\delta_T = 3.6\sqrt{\alpha x/U_\infty}$$

Flow past a flat plate



1% BL profile:

$$\delta_u = 5.0\sqrt{\nu x/U_\infty}$$

Why 5.0, not 3.6?
Continuity: y-veloc > 0, carries slow fluid upward
Convective momentum transport!

Tube Flow Friction Factor

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Please see:
Fig. 3.2 in Poirier, D. R., and G. H. Geiger. *Transport Phenomena in Materials Processing*. Warrendale, PA: The Minerals, Metals and Materials Society, 1994.

Flat Plate Global/Avg Friction Factor

Like tube flow: all shear,
sharp transition from laminar to turbulent flow

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Please see:
Fig. 3.5 in Poirier, D. R., and G. H. Geiger. *Transport Phenomena in Materials Processing*. Warrendale, PA: The Minerals, Metals and Materials Society, 1994.