3.185 Test 2 Overview

Advanced Heat Transfer and Fluid Flow

Wednesday November 12, 2003

The second test, which will take place next Wednesday to Friday, will include all of the heat transfer material (possibly including some conduction), and the first part of fluid flow, through drag force on a tube. You will be expected to know (*i.e.* memorize):

1. The Wiedmann-Franz law for metal conductivity: $k_{el} = L\sigma_{el}T$ (you need not memorize the value $L = \frac{\pi^2}{3}\left(\frac{k_B}{e}\right)^2 = 2.45 \times 10^{-8}\frac{\mathrm{W}\Omega}{\mathrm{K}^2}$)
2. The mesh Fourier number for finite difference calculations: $\mathrm{Fo}_M = \frac{\alpha\Delta t}{(\Delta x)^2}$
3. The explicit 1-D finite difference stability criterion: $\mathrm{Fo}_M \leq \frac{1}{2}$
4. Radiative heat emission from a gray surface: $(q_x =)e = \epsilon\sigma T^4$ (you need not memorize the value $\sigma = 5.67 \times 10^{-8}\frac{\mathrm{W}}{\mathrm{m}^2\mathrm{K}^4}$)
5. Viewfactor reciprocity rule: $A_iF_{ij} = A_jF_{ji}$
6. Sum of viewfactors in an enclosure: $\forall i,\ \sum_j F_{ij} = 1$
7. The Reynolds number: $\mathrm{Re} = \frac{\rho\bar{u}L}{\eta} = \frac{\bar{u}L}{\nu}$
8. Timescales to steady-state in diffusion, heat conduction and fluid flow: $t_{SS} \sim \frac{L^2}{D}$ or $\frac{L^2}{\alpha}$ or $\frac{L^2}{\nu}$
9. Kinetic energy per unit volume, a.k.a. "dynamic pressure": $K = \frac{1}{2}\rho U^2$.
10. Shear stress at a wall and local friction factor: $\tau = f_xK$
11. Drag force and global/average friction factor: $F_d = f_LKA$ (A is surface area for flow past a plate or in a tube, cross-section area for flow past a sphere; spheres and plates will *not* be on this test).

You should also be able to use the "Solving Fluid Dynamics Problems" handout (which will be provided if you need it) to cancel terms and simplify the Navier-Stokes equations.

I'm aiming for about 10-15% shorter than test 1, so it should be possible for most of you to finish this one.