

3.044 Test 1 Overview

Heat Transfer, Dimensional Analysis, Engineering Economics

Wednesday–Friday March 9–11, 2005

The second test, which will take place next Wednesday to Friday (Wednesday part in 4-149, error correction in recitation), will include all of the heat transfer material and the engineering economics unit taught by Prof. Kirchain. You will be expected to know (*i.e.* memorize):

1. Fourier's first law: $\vec{q} = -k\nabla T$
2. The energy equation for constant k and ρc_p : $\frac{\partial T}{\partial t} = \alpha \nabla^2 T + \frac{\dot{q}}{\rho c_p}$
3. Convective heat transfer boundary condition: $q_n = h(T_s - T_{fl})$
4. The (heat transfer) Biot number: $Bi = \frac{\text{solid conduction resistance}}{\text{fluid boundary layer resistance}} = \frac{hL}{k}$
5. Timescale to reach steady-state: $t_{SS} = L^2/\alpha$
6. The (heat transfer) Fourier number: $Fo = \frac{t}{t_{SS}} = \alpha t/L^2$
7. The mesh Fourier number for finite difference calculations: $Fo_M = \frac{\alpha \Delta t}{(\Delta x)^2}$
8. The explicit 1-D finite difference stability criterion: $Fo_M \leq \frac{1}{2}$
9. Radiative heat emission from a gray surface: $(q_n =) e = \epsilon \sigma T^4$ (you need *not* memorize the value $\sigma = 5.67 \times 10^{-8} \frac{\text{W}}{\text{m}^2\text{K}^4}$)
10. The Buckingham pi theorem: n variables, r base units $\Rightarrow i = n - r$ dimensionless parameters
11. Single payment: Future amount = $P(1+r)^N$
12. Series of equal payments: $A = P \cdot r \frac{(1+r)^N}{(1+r)^N - 1}$