
Week 1

Lecture 1
Information provided:
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Text: Fundamentals of Heat and Mass Transfer, Fourth Edition 1996
by F.P. Incropera and D.P. DeWitt

Students are requested to sign in.

Final Grade Components and Weights
Project: 10 points
Heat Transfer Lab.: 10 points
Mid Term Examination: 30 points
Final Examination: 50 points

ME 353 Website:
Course information will be placed at website.

Read Chapters 1 and 2.
Do Problems:
Chapter 1: 4, 11, 13, 19, 32, 46, 49, 51
Chapter 2: 2, 6, 16, 19, 29, 37

Chapter 3: 2, 10, 19, 22, 34, 43, 57, 71, 90, 101
Chapter 4: 1, 16, 20, 25, 33
Chapter 5: 5, 14, 27, 35, 46, 60, 66, 74, 77
Solutions will be available in Engineering Photocopy Center.

No Tutorial this week

Modes of heat transfer: **Conduction, Convection and Radiation**
Definitions of heat transfer by conduction, convection and radiation.
Show and tell: circulate examples of air cooled heat sinks from pentiums.

Lecture 2
Conduction: **Fourier's Law of Conduction**: $\boxed{Q = -kA\vec{n}\cdot\nabla T}$ or $\boxed{\vec{q} = -k\nabla T}$; thermal conductivity k; units of Q, q, T, ∇T; Appendix C has values of thermal conductivity for solids, liquids and gases; range of values from diamond at 2300 $W/m\cdot K$ to air at 0.0265 $W/m\cdot K$; definitions of thermal resistance R and shape factor S; their units and relationships; thermal circuit with temperature nodes, thermal resistors and throughput; series and parallel arrangement of resistors; **Newton's Law of Cooling**: $\boxed{Q = hA(T_s - T_f)}$; heat transfer coefficient h; its units; its complexity (depends on several parameters: geometric, thermophysical properties, type of flow, boundary condition, surface temperature, fluid temperature, etc.); $h = h(\rho, c_P, \mu, \nu = \mu/\rho, k_f, U_\infty, x, \text{ or } L, T_s, T_\infty)$; properties are found at film temperature: $T_{\text{film}} = (T_s + T_\infty)/2$; definitions of **Nusselt number**, **Reynolds number** and **Prandtl number** where $Nu_x = h(x)x/k_f$, $Re_x = U_\infty x/\nu$ and $Pr = \nu/\alpha$ where $\alpha = k/(\rho c_P)$; heat transfer coefficient appears in correlation equations of the form:

$$Nu_x = C Re_x^m Pr^n$$

where the parameter C, m, n depend on the type of flow (laminar or turbulent); type of fluid (high or low Prandtl number fluids); boundary condition; for example: laminar, boundary layer, forced convection over a smooth, isothermal, flat plate correlation equation is

$$Nu_x = C Re_x^{1/2} Pr^{1/3}, \quad Pr > 0.5, \quad 100 < Re < 10^5.$$

where $C = 0.332$ for local values, and $C = 0.664$ for average value over plate length L.

film resistance: $\boxed{R_{\text{film}} = 1/(hA)}$; notation used in text: q', q'', q''' denote heat transfer rate per length, per unit area, and per unit volume respectively.

Lecture 3
Survey of students experience with Spread Sheets and Computer Algebra Systems: **Excel, QuattroPro, Lotus 1,2,3** and **Mathcad, Matlab, Maple, Mathematica, Macsyma**;
Radiation heat transfer; Stefan-Boltzmann Law of Radiation; black-body emittance: $e_b = \sigma T^4$; Stefan-Boltzmann constant: $\sigma = 5.67 \times 10^{-8} W/(m^2 \cdot K^4)$. Grey-surface radiation: $E = \epsilon E_b$; surface emissivity: ϵ, a complex radiation parameter associated with real surfaces; determined empirically; $0 < \epsilon < 1$; smooth, polished, clean surfaces have low values: $\epsilon < .1$; rough, oxidized, dirty surfaces have high values near 1; net radiative heat transfer between two isothermal, grey surfaces: T_1, A_1, ϵ_1 and T_2, A_2, ϵ_2 with $T_1 > T_2$ and $A_1 < A_2$; $Q_{12} = (E_{b1} - E_{b2})/R_{\text{rad}}$; total radiation reistance consists of three resistances in series: $R_{\text{rad}} = R_{s1} + R_{s2} + R_{12}$; two grey-surface resistances: $R_{s1} = (1-\epsilon_1)/(A_1\epsilon_1)$; $R_{s2} = (1-\epsilon_2)/(A_2\epsilon_2)$; one spatial resistance: $R_{12} = 1/(A_1 F_{12})$ or $R_{12} = 1/(A_2 F_{21})$; view factors: F_{12}, F_{21} are dimensionless parameters which depend on geometry and orientation of surfaces; reciprocity relation: $A_1 F_{12} = A_2 F_{21}$; radiation circuit consists of four radiation nodes: E_{b1}, E_{b2}, J_1, J_2; radiosity: J_1, J_2.
