MNE 943: Radiation Heat Transfer – Fall 1998

Catalog Description: (3) I. Basic theories of thermal radiation, shape factors; exact and approximate solutions of integral equations of radiation heat transfer between solid surfaces with absorbing and non-absorbing media. Three hours rec. a week. Pr.: ME573

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Textbook: R. Seigel and J.R. Howell, *Thermal Radiation Heat Transfer*, 3rd ed., Hemisphere, New York, 1992.

Supplementary References: J.K. Shultis, *Radiative Transfer in Interacting Media*, class handout, 1998.

Prerequisites: (1) Calculus through differential equations (2) Programming skills (C or FORTRAN) (3) Physical science/engineering BS

Topics:

1. **Introduction** (Chapman)
   Basic radiation concepts: radiation intensity, black body radiation, Planck distribution, Wien's law, grey surfaces
   Emissivity, absorptivity, reflectivity
   Kirchoff's laws
2. **Configuration Factors** (Chapman)
   Configuration factors between two surfaces
   Radiation heat exchange between surfaces in non-interacting media
   Enclosure analyses
3. **Interacting Media** (Shultis)
   Wave-particle duality of radiation: photoelectric effect, photon and electron scattering
   Quantitites used to quantify the radiation field
   Optical properties of a medium: extinction, absorption and scattering coefficients
   Derivation of radiative Transfer Equation (RTE)
   Explicit forms of the streaming term in the RTE
   Photon Reactions: elastic and inelastic scattering mechanisms, capture interactions
   Differential scattering coefficient and the phase function
4. **Radiative Transfer in Gases** (Shultis)
   Photoexcitation and radiative transitions
   Calculation of Extinction and Emission coefficients
   Local thermodynamic equilibrium (LTE) and its consequences
   Steady-state RTE with LTE and elastic scattering
   Approximations: isotropic scattering, grey approximation, picket fence model, plane geometry.
5. **Numerical Solution of the RTE** (Shultis)
   RTE in plane-geometry and boundary conditions
   Discrete-ordinates method
   Multi-flux Methods
   Differential or Diffusion Approximation
6. **Application to Combustion of Particle Suspensions** (Shultis)
   Heat generation from burning carbonaceous particles
   Optical properties
   Iterative solution for temperature and radiation intensity
   Ignition

Prepared by: J. Kenneth Shultis, Professor. 12/22/98