Course Outline
MSE 3012: Thermal and Transport Properties of Materials
Prof. R. F. Speyer

1. INTRODUCTION: TEMPERATURE, HEAT, WORK, ENERGY
2. FURNACES
   (a) Temperature Transducers (Speyer)
   (b) Electric Furnace Components (Speyer)
   (c) PID Control (Speyer)
3. HEAT CAPACITY
   (a) Definitions (Castellan)
   (b) Heat Capacities of Gases (Castellan)
   (c) Introduction to Statistical Thermodynamics (Kittel)
   (d) Einstein/Debye Models for Heat Capacity of Solids (Castellan, Zemansky)
4. DIFFERENTIAL THERMAL AND THERMOGRAVIMETRIC ANALYSES
   (a) Introduction to DTA and Power-compensated DSC (Speyer)
   (b) Transformation, Thermodynamic, and Kinetic Data from DTA (Speyer)
   (c) Transformation Categories (Speyer)
   (d) Heat Capacity Effects (Speyer, Zemansky)
   (e) Experimental Concerns (Speyer)
   (f) Thermogravimetric Analysis (Speyer)
5. THERMAL EXPANSION
   (a) CTE Behavior of Solids (Speyer, Kingery)
   (b) Dilatometry (Speyer)
   (c) Interferometry (Speyer)
6. HEAT CONDUCTION
   (a) The Continuity Equation (Holman)
   (b) Equivalent Circuit Analysis (Incropera)
   (c) Finite Difference Analysis of 2-dimensional Conduction (Incropera)
   (d) Transient Conduction (Incropera)
   (e) Thermal Conduction Processes in Solids (Kingery, Speyer)
   (f) Thermal Conductivity Measurement (Speyer)
7. FLUIDS
   (a) Viscous Properties of Fluids (Poirier)
   (b) Convection Boundary Layers (Incropera)
   (c) Laminar and Turbulant Flow (Incropera)
   (d) Heat Transfer through Phase Transformations (Incropera)
8. THERMAL RADIATION
   (a) Introduction

(b) Classical Theory of Cavity Radiation (Resnick)

(c) Planck's Theory of Cavity Radiation (Resnick)

(d) Stephan-Boltzmann and Wein Displacement Laws (McGee, Incropera)

(e) Emissivity and Radiative Behavior of Solids (Siegel, Speyer)

(f) Radiation Exchange (Incropera)

(g) Case Study of Radiation Exchange

(h) Radiation Measurement

(i) Pyrometry (Speyer, McGee)

REFERENCES

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2. J. P. Holman, *Heat Transfer*, 8th ed., McGraw-Hill, New York, 1997.
3. T. D. McGee, *Principles and Methods of Temperature Measurement*, John Wiley and Sons, New York, 1988.
4. R. J. Reed, *North American Combustion Handbook*, 3rd ed., North American Mfg. Co., Cleveland, OH, 1986.
5. R. Siegel and J. R. Howell, *Thermal Radiation Heat Transfer*, 3rd ed., Hemisphere Publishing Corp., Washington, DC, 1992.
6. W. D. Kingery, H. K. Bowen, D. R. Uhlmann, *Introduction to Ceramics*, 2nd ed., John Wiley and Sons, New York, 1976.
7. C. Kittel and H. Kroemer, *Thermal Physics*, 2nd ed., W. H. Freeman and Co., San Francisco, CA, 1980.
8. R. Eisberg and R. Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*, 2nd ed., John Wiley and Sons, New York, 1985.
9. M. W. Zemansky and R. H. Dittman, *Heat and Thermodynamics*, 6th ed., McGraw Hill Book Co., 1981.
10. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 5th ed., John Wiley and Sons, 1997.
11. F. P. Incropera and D. P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 2nd ed., John Wiley and Sons, New York, 1985.
12. G. W. Castellan, *Physical Chemistry*, 3rd ed., Addison Wesley, Reading, MA, 1983.
13. D. R. Poirier and G. H. Geiger, *Transport Phenomena in Materials Processing*, The Minerals, Metals and Materials Society, Warrendale, PA, 1994.