MAE625 – Radiation Heat Transfer

Course Syllabus

Instructor: Dr. Terence Musho, PE

Spring 2025

Instructor: Dr. Terence Musho, PE
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Office Hours: T 1:00 PM - 2:00 PM (In-person) or R 11:00 AM - 12:00 PM (Teams)

Lecture: MWF 11:00 – 11:50 PM
Room: ESB-E851 or Collaborate Ultra

Optional Texts:

- *Radiative Heat Transfer*, M. F. Modest, 3rd Edition, Academic Press (Available via WVU eLibrary)
- *Thermal Radiation Heat Transfer*, R. Siegel and J. R. Howell, 5th Edition, CRC Press
- *Fundamentals of Heat and Mass Transfer*, F. P. Incropera et al.

Course Objectives:

- Develop advanced knowledge and analytical skills to solve radiation heat transfer problems.
- Understand and apply radiation properties of surfaces and participating media.
- Gain proficiency in numerical methods for solving radiative heat transfer equations.
- Explore applications of radiation in engineering systems.

Grading:

- Take-Home Midterm Exam: 35%
- Term Paper (Final): 35%
- Homework: 25%
- In-Class Activities: 5%

Class Rules

Attendance and Participation

- Regular attendance and punctuality are expected.
- Notify the instructor in advance if you need to miss a class.
- Engage in discussions and group activities actively.

Assignments and Deadlines

- Submit assignments on time. Late submissions may incur penalties unless prior arrangements are made.
- Seek help early for assignment difficulties; extensions may be granted in exceptional circumstances.

Academic Integrity

- Maintain academic integrity. Plagiarism or cheating will result in disciplinary action.
- Collaboration is allowed where specified but ensure your work reflects personal understanding.

Tentative Course Schedule:

Week	Topics	Reading Assignment - Modest Book
Week 1	Introduction to Thermal Radiation	Chapter 1.1-1.3: Fundamentals of Thermal Radiation
Week 2	Blackbody Radiation, Radiation Laws	Chapter 1.3–1.7: Basic Laws and Emissive Power
Week 3	Radiative Properties of Real Surfaces	Chapter 3: Radiative Properties of Real Surfaces
Week 4	View Factors, Radiative Exchange Between Surfaces	Chapter 4: View Factors
Week 5	Radiative Network Analysis, Radiation Shields	Chapter 5.1–5.5: Gray Diffuse Surface Exchange
Week 6	Midterm Exam Preparation and Review (Take-Home Distributed)	Review Chapters 1–5
Week 7	Radiation in Participating Media	Chapter 10.1–10.4: RTE in Participating Media
Week 8	Radiative Transfer Equation (RTE)	Chapter 10.5–10.12: Solution Methods for RTE
Week 9	Numerical Methods: Discrete Ordinates Method	Chapter 17.1–17.3: SN-Approximation
Week 10	Monte Carlo Method (Basics)	Chapter 8.1–8.5: Fundamentals, Ray Tracing, and Surface Exchange
Week 11	Monte Carlo Method (Advanced Applications)	Chapter 8.6–8.7: Efficiency Considerations, Advanced Topics
Week 12	Radiation in Furnaces	Supplemental Materials Provided by Instructor
Week 13	Solar Radiation Applications	Chapter 18.6: Direct Exchange Areas
Week 14	Additional Topics	No Additional Readings
Week 15	Term Paper Submission	No Additional Readings

Tentative Homework Schedule:

Week	Topic	Homework Description	Due Date
Week 1	Fundamentals of Radiation	Solve problems on blackbody radiation and basic radiation laws. Focus on emissive power and spectral properties.	Week 2
Week 2	Blackbody Radiation and Laws	Apply Stefan-Boltzmann law and Wien's displacement law. Derive radiative properties for blackbody systems. Problems from Modest Chapter 1.5–1.7.	Week 3
Week 3	Radiative Properties of Real Surfaces	Calculate emissivity and reflectivity for different materials. Use data for metals and dielectrics. Problems from Modest Chapter 3.1–3.4.	Week 4
Week 4	View Factors	Compute view factors using integration and algebraic methods. Problems include common geometries like parallel plates and perpendicular surfaces. Modest Chapter 4.2–4.6.	Week 5
Week 5	Radiative Exchange Between Surfaces	Solve network problems for radiative exchange in gray, diffuse enclosures. Include cases with radiation shields. Problems from Modest Chapter 5.2–5.5.	Week 6
Week 6	Review and Midterm Prep	Review all homework problems for Chapters 1–5. Additional practice problems assigned for review.	Week 7
Week 7	Radiation in Participating Media	Derive and solve problems involving the radiative transfer equation (RTE) for absorbing and scattering media. Modest Chapter 10.1–10.4.	Week 8
Week 8	Radiative Transfer Equation (RTE)	Apply solution methods for RTE, including integral and numerical techniques. Problems from Modest Chapter 10.5–10.12.	Week 9
Week 9	Discrete Ordinates Method (SN)	Implement the SN approximation for 1D and 2D problems. Solve for radiative fluxes in simple enclosures. Modest Chapter 17.2–17.4.	Week 10
Week 10	Monte Carlo Method (Basics)	Solve problems involving random number generation and ray tracing for surface exchange. Use Modest Chapter 8.1–8.5 for guidance.	Week 11
Week 11	Monte Carlo Method (Advanced)	Apply Monte Carlo techniques to complex systems, including particulate media and efficiency analysis. Problems from Modest Chapter 8.6–8.7.	Week 12
Week 12	Radiation in Furnaces	Analyze radiation heat transfer in furnace applications using simplified models. Supplemental problems provided by instructor.	Week 13
Week 13	Solar Radiation Applications	Design a solar collector or evaluate solar radiation properties. Use data and methods from Modest Chapter 18.6.	Week 14
Week 14	Term Paper Preparation	Prepare for term paper submission. Optional problems on advanced radiative exchange areas for additional practice.	Week 15