MAE 623 – Conduction Heat Transfer

Instructor: Dr. Terence Musho, PhD, PE
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Office Hours: MW 11:00–12:00 PM (in person or Teams)
Lecture: MWF 10:00–10:50 PM, ESB-441

Course Description

This course provides advanced knowledge and tools for solving complex conduction heat transfer problems. Emphasis is placed on analytical and approximate techniques, with extensions to microscale transport and numerical methods. Students will apply both theoretical and computational approaches to real-world conduction problems.

Texts and References

Primary Text: D. W. Hahn and M. N. Özışık, *Heat Conduction*, 3rd Ed., Wiley, 2012.
Supplemental References:

- J.V. Beck, *Heat Conduction using Green's Functions*
- Z. Zhang, *Nano/Microscale Heat Transfer*
- M.N. Özışık, *Inverse Heat Transfer: Fundamentals and Applications*
- F.P. Incropera et al., *Introduction to Heat Transfer*

Course Objectives

- Derive and solve the heat equation in Cartesian, cylindrical, and spherical coordinates.
- Apply orthogonal functions, separation of variables, and integral transform techniques.
- Use Duhamel's theorem, Laplace transforms, and Green's functions for transient problems.
- Model conduction in composite media, phase-change systems, and moving heat sources.
- Evaluate the limits of Fourier's law at the microscale.
- Interpret solutions in the context of engineering systems and research.

Grading

Coursework Breakdown:

- Homework Assignments: 30%
- Midterm Exam: 30%
- Term Paper: 30%
- Participation/Activities: 10%

Policies

- Attendance is expected; participation in discussions is strongly encouraged.
- Homework is due on the posted date. Late work may be penalized unless arranged in advance.
- All submitted work must be original. Collaboration on homework is allowed only where specified.

- Exams are closed book unless otherwise stated. Academic integrity will be strictly enforced.
- Laptops/tablets are allowed for course-related activities only; phones must be silenced.
- Students requiring accommodations should notify the instructor early in the semester.

Tentative Course Schedule

Week	Lecture Topic	Reading (Hahn)	Assignment
1	Heat conduction fundamentals; Fourier's law; heat equation; BCs and ICs	Ch. 1.1–1.6	—
2	Orthogonal functions; Sturm–Liouville; Fourier series	Ch. 2	HW 1 Assigned
3	Separation of variables; 1D transient and 2D steady problems	Ch. 3.1–3.4	—
4	Semi-infinite/infinite domains; error functions; similarity solutions	Ch. 6.1–6.3	HW 1 Due / HW 2 Assigned
5	Cylindrical problems; Bessel functions; radial conduction	Ch. 4.1–4.3	—
6	Spherical problems; Legendre polynomials; transient conduction	Ch. 5.1–5.3	HW 2 Due / HW 3 Assigned
7	Duhamel's theorem; time-dependent BCs and sources	Ch. 7	—
8	Laplace transform method; transient solutions	Ch. 9	HW 3 Due / HW 4 Assigned
9	Green's function approach; delta functions; source representations	Ch. 8.1–8.3	—
10	Green's function applications; Cartesian/cylindrical/spherical	Ch. 8.4–8.7	HW 4 Due / HW 5 Assigned
11	Composite media; multilayer slabs and cylinders	Ch. 10	—
12	Moving heat sources; welding and scanning analogies	Ch. 11	HW 5 Due / HW 6 Assigned
13	Phase change and Stefan problems; enthalpy methods	Ch. 12	—
14	Approximate methods: integral method; Galerkin approach	Ch. 13	HW 6 Due / HW 7 Assigned
15	Integral transforms; Hankel and finite transforms; applications	Ch. 14	—
16	Anisotropy and microscale conduction; limits of Fourier law	Ch. 15, 16	HW 7 Due / HW 8 Assigned
17	Term paper presentations; comprehensive review	—	HW 8 Due