Syllabus

MEMS 1052 – Heat and Mass Transfer

Spring Semester 2025

Lecture Time:	Mon. 08:15 – 11:00	**Classroom:**	SCUPI New Bldg. S104
Instructor:	Dr. John Pien	**Office:**	SCUPI New Bldg. N503
Office Hours:	Mon. 11:00 – 12:00 Mon. 13:30 – 17:30 Tue. 09:00 – 11:00	**Email:**	john.pien@scupi.cn

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Course Description

This course provides an introductory treatment of the modes of heat transfer in conduction, convection and radiation, as well as diffusion mass transfer. Course topics include steady and unsteady-state conduction, heat sink applications, thermal resistance network, forced convection in internal and external flows, fundamental principles of radiation and diffusion mass transfer. The similarities between heat transfer and mass transfer are also introduced.

Prerequisites

MSE 0048 Thermodynamics of Materials or ME0051 Introduction to Thermodynamics.

Textbook

Incropera, DeWitt, Bergman and Lavine, *Principles of Heat and Mass Transfer*, 1st Ed., Global Edition, SI Version, Wiley.

Course Objectives

Upon successful completion of this course, the students will be able to:

1. Provide an understanding and appreciation of the physical mechanisms of heat and mass transfer.
2. Develop the ability to properly use the analytical and empirical descriptions of heat and transfer mechanisms.
3. Apply the heat and mass transfer principles to the analysis of thermal systems and at the same time consider the impact of solutions in energy reduction and environmental sustainability.

Applicable ABET Student Outcomes

- Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

- Ability to apply engineering design to produce solutions that meet specified needs with consideration of global, environmental and economic factors.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, environmental and economic contexts (sustainability, for example).
- Ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Outline

- Introduction (Ch. 1)
- Introduction to Conduction (Ch. 2)
- 1D Steady-State Conduction (Ch. 3)
- 2D Steady-State Conduction (Ch. 4)
- Transient Conduction (Ch. 5)
- Introduction to Convection (Ch. 6)
- External Flow (Ch. 7)
- Internal Flow (Ch. 8)
- Radiation (Ch. 12)

Course Schedule (Tentative)

Week	Date	Chapter	Topics
1	02/24	1.1 1.2	Introduction: What and How Physical Origins and Rate Equations: Conduction, Convection
2	03/03	1.2 1.3	Physical Origins and Rate Equations: Radiation Relationship to Thermodynamics
3	03/10	1.3 1.4-1.5 2.1-2.2 2.3	Relationship to Thermodynamics Units and Dimensions, Methodology for Analysis Conduction Rate Equation, Thermal Properties Heat Diffusion Equation
4	03/17	2.4 3.1	Boundary and Initial Conditions 1-D, Steady-State Conduction (Plane Wall)
5	03/24	3.3 3.4 3.5 3.6	1-D, Steady-State Conduction (Radial System) 1-D, Steady-State Conduction (Summary) 1-D, Steady-State Conduction (with Thermal Energy Generation) Extended Surface
6	03/31	3.6 4.1	Extended Surface 2-D, Steady-State Conduction (General)
7	04/07		Midterm Exam-I
8	04/14	4.3 5.1-5.3 5.4 6.1	2-D, Steady-State Conduction (Shape Factor) Transient Conduction (Lumped Capacitance Method) Spatial Effect Convection Boundary Layers

9	04/21	6.2 6.3	Local and Average Convection Coefficients Laminar and Turbulent Flow
10	04/27	6.4-6.5 6.6-6.7	Boundary Layer Equations, Boundary Layer Similarity Dimensionless Parameters, Boundary Layer Analogies
10	04/28	7.1 7.2 7.4-7.5	External Flow (Empirical Method) External Flow (Flat Plate in Parallel Flow) External Flow (Cylinder in Cross Flow, Sphere in Cross Flow)
11	05/05		Labor Day Holiday → makeup class on 04/27
12	05/12		Midterm Exam-II
13	05/19	8.1 8.2	Internal Flow (Hydrodynamic Considerations) Internal Flow (Thermal Considerations)
14	05/26	8.3 8.4	Internal Flow (Energy Balance) Internal Flow (Laminar Flow in Circular Tubes)
15	06/02		Duan-Wu Holiday
16	06/09	8.5 8.6 12	Internal Flow (Turbulent Flow in Circular Tubes) Internal Flow (Noncircular Tubes) Radiation (Brief Introduction)
17	06/16		Final Exam

Exam Schedule (Tentative)

Midterm Exam I	9:00 – 11:00, Mon., Apr. 7th (week 7)
Midterm Exam II	9:00 – 11:00, Mon., May 12th (week 12)
Final Exam	9:00 – 11:00, Mon., Jun. 16th (week 17)

Course Grading

Attendance/Quiz	10%
Homework	20%
Midterm Exam I	20%
Midterm Exam II	20%
Final Exam	30%

Course Policies

Regular class attendance is essential and expected. Active participation in course activities is encouraged which would generally involve focused thinking as well as engaging with instructor and fellow students. Professional classroom demeanor is required; in particular, all cell phones and personal electronic devices must remain off or silent during the lecture. Do not conduct side conversations during the lecture as it is distracting to the lecturer and other students.

Homework Assignments

- Homework problems are assigned periodically and are due as stated in the assigned paper. All work should be submitted electronically through the Blackboard system. Late

submission WILL NOT be accepted. It is students' duty to make sure that submission through Blackboard has been properly processed. If you have a compelling emergency that prevents you from turning in the homework on time, please email the instructor to get the approval for late submission. All homework scores will be used in your grade computation.

- Unless otherwise indicated, you can work with your fellow classmates, but you must submit a distinct and independent write-up to receive credit. If plagiarism is caught, the homework will receive a zero score. If you believe an error has been made in the grading of an assignment, bring it to the attention of the TA or instructor within one week (7 calendar days) after the graded materials have been made available to the student.
- All work must be shown for each solution to receive full credit and present your solution in a logical fashion while showing and explaining all important steps in detail.

Exams

- There will be three exams (two midterms and one final), all are closed-book and closed-notes. Essential equations will be provided to students during the exams to help answer exam problems. Exams will emphasize treatment of materials covered in lectures and homework assignments.
- If you cannot attend an exam due to emergencies and health issues, you MUST get the approval from the instructor to make alternative arrangements, consistent with University Policy, before the exam is given. If you miss an exam without prior approval, you will receive a score of "ZERO" for that exam except under extenuating circumstances.

Make-Up Exam

Students who have not taken either the midterm or the final exam are NOT eligible to take the make-up exam. The make-up exam grading is only to replace students' semester final exam grading. Students who pass the course after the make-up exam will receive only a passing grade as the final grade.

Evaluation Policy

Partial credit will be awarded to recognize that some portion of the work is correct. However, partial credit grading is only practical if the work is clearly developed, with clear and well-marked diagrams when fitting, with the appropriate equations prominently displayed, where the substitutions into the equations are quite clear, and the assumptions used are obvious to the grader. That is, it is the student's responsibility to present her/his work so clearly that the grader can quickly ascertain the location and nature of the error(s) and can follow the subsequent work through. If this is not clear on the work submitted, credit cannot be given. Partial credit is assigned at the discretion of the grader. It is

therefore always in your best interest to practice clarity and completeness in your solutions when working on exam and homework problems.

Copyrights

The handouts used in this course are copyrighted. By "handouts" we mean all materials generated for this class, which include but are not limited to syllabi, in-class materials, videos, slides, and problem sets. Because these materials are copyrighted, you do not have the right to copy or distribute the handouts, unless the author expressly grants permission.

Academic Integrity

All students are expected to adhere to the standards of academic honesty. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include but is not limited to the confiscation of the examination of any individual suspected of violating the University Policy.

Remarks

- Modifications to this syllabus may occur. Please stay informed about any revisions announced during class or on the Blackboard website. Lecture materials, homework assignments, homework solutions and class announcements will also be accessible through Blackboard.
- Important dates and information will be announced during class. Students should stay informed about announcements on Blackboard.
- While emailing the instructor or TAs, please kindly include “MEMS 1052” in the subject line for an efficient communication. Please use your university email account (student_ID_number@stu.scu.edu.cn), as emails from other sources could be caught by the SCU spam filter.