

MAE 505 – Heat Transfer Theory and Applications

Summer 2025 - Section 651

Online Class

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Online Office Hours: TBD based on the online poll

1.1. Course Prerequisites: Undergraduate course in convective heat transfer and fluid flow or consent of instructor

1.2. Textbook: Adrian Bejan, Heat Transfer, Wiley, NY, 1993

1.3. Reference Material: ERG Eckert and RM Drake, Analysis of Heat and Mass Transfer, Hemisphere, NY, 1987

Fundamentals of Heat and Mass Transfer, 7th Ed, by Bergman, Lavine, Incropera & DeWitt, John Wiley & Sons, 2011.

J.C. Slattery, Advanced Transport Phenomena, Cambridge University Press, NY, 1999

W.M. Kays and M.E. Crawford, Convective Heat and Mass Transfer, 3rd edition, McGraw Hill, NY, 1993

H. Schlichting, Boundary-Layer Theory, McGraw Hill, NY, 1979

C. Kleinstreuer, Engineering Fluid Dynamics, Cambridge University Press, NY, 1996.

Heat Transfer and Fluid Mechanics Journals, Heat Transfer Conference Proceedings, etc.

1.4. Course Support: <http://engineeringonline.ncsu.edu>
Moodle site - <https://wolfware.ncsu.edu/>

1.5. Course Objectives: The students will be asked to demonstrate their knowledge of the material covered in MAE 505 through their mastery of the following course objectives. Through the study of MAE 505 the students will be able to:

1. Understand physical meaning and mathematical nature of heat-conduction equation
2. Be able to solve unidirectional steady heat conduction problems
3. Be familiar with solution methods for multidirectional steady heat conduction problems
4. Use Fourier method for solving time-dependent heat conduction equation
5. Analyze heat conduction with moving boundaries, melting and solidification
6. Understand and solve problems for external forced convection in laminar flow
7. Understand theory and applications of internal forced convection in laminar flow
8. Determine heat transfer coefficient in natural convection along a vertical wall and in an enclosure heated from the side, laminar flow
9. Analyze external forced convection in turbulent flow
10. Understand and solve equations for internal forced convection in turbulent flow
11. Understand basic thermal radiation concepts and relations as well as blackbody radiation
12. Calculate heat transfer between black surfaces
13. Understand calculation methods for diffuse-gray surfaces

1.6. Grading

Homeworks	10%
Exam 1	20%
Exam 2	20%
Project	25%
Final Exam	25%

No incompletes are accepted for this course without verifiable, written doctor's note indicating more than one week's incapacitation. The final grade will be based on the final average and determined as follows:

Letter	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Highest,%	100.0	96.9	92.9	89.9	86.9	82.9	79.9	76.9	72.9	69.9	66.9	62.9	59.9
Lowest,%	97.0	93.0	90.0	87.0	83.0	80.0	77.0	73.0	70.0	67.0	63.0	60.0	0

Plus/minus grades will be used for the border line cases based on attendance, homework grades, and improvement in test and exam grades.

1.7. Tentative Course Outline

Heat Conduction

Heat-Conduction Equation (1.3) (2 lectures)

Unidirectional Steady Heat Conduction (2.1-2.6) (2 lectures)

Multidirectional Steady Heat Conduction (3.1) (2 lectures)

Time-Dependent Conduction (4.1-4.4) (2 lectures)

Heat Conduction with Moving Boundaries, Melting and Solidification (4.7) (1 lecture)

Exam I ***June 13 – 17***

Heat Transfer by Convection

External Forced Convection in Laminar Flow (5.1-5.3) (3 lectures)

Internal Forced Convection in Laminar Flow (6.1-6.2) (3 lectures)

Natural Convection along a Vertical Wall and in an Enclosure Heated from the Side,
Laminar Flow (7.1-7.4) (3 lectures)

External Forced Convection in Turbulent Flow (5.4) (3 lectures)

Internal Forced Convection in Turbulent Flow (6.3) (2 lectures)

Exam II ***July 11 – 15***

Thermal Radiation

Basic Concepts and Relations, Blackbody Radiation (10.1-10.2) (2 lectures)

Heat Transfer between Black Surfaces (10.3) (2 lectures)

Diffuse-Gray Surfaces (10.4) (2 lectures)

Project ***Due Thursday, July 24th***

Final Exam ***July 28 – 29***

1.8. Course Policies

1.8.1 Exams

Exams I and II are take-home exams. The final exam will be an open book, open notes exam but will be proctored. The preliminary exam schedule is provided in the class syllabus. Exams I and II will be posted as Moodle assignments and must be submitted electronically. The final exam can be scheduled with a proctor between 8 AM EST on July 28th and 9 PM EST on July 29th. There must be no collaboration on the exams. Arrangements for missed exams will be made on an individual basis provided you have an acceptable, certifiable excuse.

1.8.2 Homeworks

Homeworks will be assigned on Thursday of the current week of class and will be due on Thursday of the following week. The homeworks will be posted as Moodle Assignments set up for electronic submission and grading.

1.8.3 Instructor's policies on incomplete grades and late assignments

Incompletes are accepted only for medical reasons. Makeup work, if any, must be arranged within two weeks of the due date at the option of the instructor, prior to two weeks before the end of classes. Arrangements for missed tests will be made on an individual basis provided you have an acceptable, certifiable excuse.

1.8.4 Academic Integrity statement

The faculty acknowledges the existence of the University policy on academic integrity found in <http://studentconduct.ncsu.edu/> and expects students to adhere to it.

An Honor Pledge is expected to be signed and dated on each exam, final exam, and any additional special assignments. The Honor pledge will be as follows: "I have neither given nor received unauthorized aid on this test, exam or special assignment. I have not discussed the contents of this test or exam prior to taking it."

It is the expectation of faculty that students neither give nor receive unauthorized aid on any exam, or special assignment. The faculty recognizes the value of discussions by students regarding weekly homework assignments in student groups, with teaching assistants, and the faculty. However, homework assignments submitted for grading must be the product of the student submitting the work.

1.8.5 Statement for students with disabilities

Reasonable accommodation will be provided for students with verifiable disabilities. In order to take advantage of available accommodation, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities at <http://policies.ncsu.edu/regulation/reg-02-20-01>.

1.8.6 Class evaluation

Online class evaluations will be available for students to complete during the last week of class. Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential; instructors will never know how any particular student responded to any question, and students will never know the ratings for any particular instructor.

More information about ClassEval is available at <https://isa.ncsu.edu/for-the-pack/classeval/>

1.8.7. Online class organization

Pre-recorded Lectures: We will have twenty-eight (28) pre-recorded asynchronous lectures posted in Panopto format. The lecture slides are posted online. The links to the video lectures will be provided just below the lecture slides, separately for each lecture.

Homeworks: Homeworks are posted using Moodle Assignments and should be submitted electronically. Please submit your files as PDF (preferred) or web image files. There is a limit of 10 files/10 MB total for each submission. The homeworks will be graded electronically. The maximum for each homework will be 100 points. The homework solutions will be posted as pdf files.

Homework Forums: HW forums will be open to discuss homeworks and post questions. All students are encouraged to participate.

Office Hours: I will conduct my office hours via Zoom. The timing will be determined based on a Moodle poll, where students can vote for the hours that work best for them. Option for irregular office hours: you can always send me an invite for a Zoom meeting. I will accept if I am available.

Note: this syllabus is not a contract and can be altered at any point with advanced notice to accommodate the educational goals of the course or the state of the pandemic.