

EML 6154: Conduction Heat Transfer

Class Periods: MWF 4:05 – 4:55

Location: NEB 0102

Academic Term: Fall 2024

Instructor

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(352)-392-7164

Office Hours: MW 1:00 – 2:00

Preferred Contact: Please contact through the canvas website <https://ufl.instructure.com>

Teaching Assistants

NA

Course Website

<https://ufl.instructure.com/> (Canvas)

Additional material will be uploaded on the Canvas website. Please check Canvas before each lecture.

Course Description

Heat conduction in homogeneous, heterogeneous, isotropic, anisotropic, stationary, and moving bodies; in Cartesian, cylindrical and spherical systems. Examines exact and approximate solutions. (Credits 3)

Course Pre-Requisites / Co-Requisites

It is expected that students will have had course work in mathematics (particularly in differential equations and integration) and in numerical methods (root finding, plotting, curve fitting, solving systems of ODEs, etc.). Previous course work in heat transfer will be useful but is not necessary.

Course Objectives

This course develops mathematical skills in solving the heat equation using analytical techniques. Emphasis will be placed on deriving governing equations from energy balances, deriving and properly choosing boundary conditions, and solving the governing equations using analytical mathematical techniques. Transient and steady-state analysis of multidimensional systems in Cartesian, cylindrical, and spherical coordinates will be performed using a variety of mathematical methods including separation of variables, superposition, eigenfunction expansions, and Green's functions.

Learning Outcomes:

Specifically, students will have the ability to:

1. Derive governing equations and boundary conditions for conduction heat transfer from an energy balance for a variety of scenarios.
2. Use Trigonometric, Bessel, Legendre and other orthogonal functions to decompose arbitrary functions in Fourier series.
3. Solve the heat equation using a combination of separation of variables, superposition, eigenfunction expansions, and Green's functions in Cartesian, cylindrical, and spherical coordinate systems.
4. Use computer software to visualize the resulting analytical solutions of the heat equation.
5. Use symbolic computer algebra software such as Mathematica to analytically differentiate, integrate, solve differential equations, solve algebraic equations, etc.

Materials and Supply Fees

None

Required Textbooks and Software

- David W. Hahn, M. Necati Ozisik, Heat Conduction, Wiley, 3rd Edition, 2012, ISBN: 978-1-118-32198-0 (Required)
- Access to Python3 (which is open source, freely available, and multiplatform) or Matlab
- Wolfram Mathematica (available on UF Apps <https://login.apps.ufl.edu/Citrix/UFAppsWeb/>) will be helpful.

Recommended Materials

- Latif M. Jiji, Heat Conduction, Springer-Verlag, 3rd Edition, 2009 (Optional Reference, PDF freely available to UF students via Springer Link <https://link.springer.com/book/10.1007/978-3-031-43740-3>)
- Kevin D. Cole, James V. Beck, A. Haji-Sheikh, Bahaman Litkouhi, Heat Conduction Using Green's Functions, Taylor and Francis, 2nd Edition, 2011 (Optional Reference, Freely Available from UF library)

Required Computer

UF student computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>

Important Dates

Classes Begin: Aug 22

Holidays (No class): Sept 2, Nov 11, Nov 25 – Nov 29

Midterms (No class): Sept 25, Oct 2

Classes End: Dec 4

Course Outline

1. Heat Conduction Fundamentals: *Chapter 1 and Chalkboard Notes*
2. Solution Methods for Cartesian Coordinates: *Chapter 3 and Chalkboard Notes*
 - a. Fourier series and orthogonal functions
 - b. Separation of variables
 - c. Eigenfunction expansions
 - d. Superposition
 - e. Methods for time dependent boundary conditions and source terms
 - i. Eigenfunction expansions (not in book)
 - ii. Removal of inhomogeneous boundary conditions (not in book)
3. Solution Methods for Cylindrical Coordinates: *Chapter 4 and Chalkboard Notes*
 - a. Sturm-Liouville Theory and Fourier-Bessel Expansions: *Chapter 4 and Chalkboard Notes*
 - b. Solution of homogeneous and inhomogeneous problems in cylindrical coordinates using separation of variables, eigenfunction expansions, and superposition
4. Solution Methods for Spherical Coordinates: *Chapter 4 and Chalkboard Notes*
 - a. Fourier-Legendre series
 - b. Solution of homogeneous and inhomogeneous problems in spherical coordinates using separation of variables, eigenfunction expansions, and superposition
5. Solution of the Heat Equation in Semi-Infinite and Infinite Domains: *Chapter 6*
6. Duhamel's Theorem and Green's Function: *Chapters 7 and 8*
7. Laplace Transform Methods: *Chapter 9* (time permitting)

Exams

Midterm 1: Sept 25, 2024 (tentative)

Midterm 2: Oct 2, 2024 (tentative)

Final Exam: Dec 11, 2024 5:30 – 7:30 PM (Wednesday during finals week)

Make-up Exam Policy

Unexcused absences from exams will not be tolerated. Make-up exams will be allowed only under the most extenuating circumstances as required by University policy. Students must notify the instructor of any anticipated conflicts *prior* to the exam. See <https://care.dso.ufl.edu/instructor-notifications>. Note that, "Professors have the right to accept or reject the notification."

Homework

Homework will be assigned regularly and is due on the announced due date. Please submit homework assignments on Canvas. There will be occasional "project problems". These project problems will be longer-duration problems that ask you to analyze scenarios starting from scratch that expect you to derive governing equations, make appropriate assumptions, develop an analytical solution, and analyze the results.

Students are encouraged to collaborate with their colleagues; however, each student will turn in their homework individually. Students are encouraged to use symbolic mathematical software such as Mathematica. However, be sure to know how to perform the mathematical operations as computer software will not be allowed during exams. Copying homework problems from solution manuals and other resources will be considered cheating and will not be tolerated.

Computer software

Many homework problems will require the use of computer software for visualization and function evaluation. Students are encouraged to install and use Python3; however, Matlab will also work. Please note that Matlab help will be limited and homework solutions for computer work will be in Python3.

Evaluation of Grades

Homework	30%
Midterm 1	20%
Midterm 2	20%
Final Exam	30%

Attendance Policy

On-campus students are expected to attend lectures in-person during class time.

Grading Policy

The instructor may adjust this scale in the final analysis, but in no case will scores be higher than those listed be required to achieve the stated letter grades.

Percent	Grade	Grade Points
93.0 - 100.0	A	4.00
90.0 - 92.3	A-	3.67
87.0 - 89.9	B+	3.33
83.0 - 86.9	B	3.00
80.0 - 82.9	B-	2.67
77.0 - 79.9	C+	2.33
73.0 - 74.9	C	2.00
70.0 - 72.9	C-	1.67
67.0 - 69.9	D+	1.33
63.0 - 66.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Grade Dispute

If there is a mistake in grading or you think that you have been graded unfairly, explain your dispute with the instructor within **one week** after the assignment, quiz, exam, etc. is returned. After one week, the grade dispute will **not** be considered.

Use of Class Materials

The materials used in this class, including, but not limited to, exams, quizzes, and homework assignments are copyright protected works. Any unauthorized copying of the class materials is a violation of federal law and may result in disciplinary actions being taken against the student. Additionally, the sharing of class materials without the specific, express approval of the instructor may be an act of academic dishonesty, which could result in further disciplinary action. This includes, among other things, uploading class materials to websites for the purpose of sharing those materials with other current or future students.

Class Expectations

- The student is solely responsible for their education. The professor is the guide to their understanding of the field.
- Cell Phones, Laptops, etc.: Under no circumstances will electronic devices be used in the classroom without the permission of the professor. Students are expected to take hand-written notes.
- Respect and Disruption: The professor and students will be respectful at all times. Classroom disruption of any kind will not be tolerated.

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history,

academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Coordinator
- HWC OE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.