

EML 4140 20321 Section 5964 – Heat Transfer Fall 2021

Class Periods: T4 10:40-11:30 am R4-5 10:40am-12:35pm

Location: **FLG 0220**

Instructor

- Subrata Roy, Ph.D.
- Office location: MAEB 336
- Office Hours: Online (TBD)
- Email: roy@ufl.edu

Supervised Teaching Assistant

Hashnayne Ahmed

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Office hours and location: M 4 (10:40 am – 11:30 am); W 3-4 (9:35 am – 11:30 am); F 4 (10:40 am – 11:30 am) MAE-C 125 (Please contact through the Canvas website, <http://elearning.ufl.edu/>)

TA Grader

TBA

Email:

Office location and hours: (Please contact through the Canvas website, <http://elearning.ufl.edu/>)

Course Description:

Steady-state and transient analysis of conduction and radiation heat transfer in stationary media. Heat transfer in fluid systems, including forced and free convection. Credits:3

Course Pre-Requisites / Co-Requisites

CGS 2425, EML 3100, EGM 4313

Course Objectives and Outcomes

This course provides an intermediate level coverage of thermal transport processes via conduction, convection, and radiation heat transfer. This course stresses fundamental engineering science principles applied to engineering thermal analysis. Students will learn to apply the conservation of energy to control volumes and express the conservation of energy through mathematical formulations, including both steady-state and transient analyses, with emphasis on the fundamental physics and underlying mathematics associated with heat transfer. Upon completion of this course, students are expected to understand basic heat transfer problem formulation and solution techniques, coupled with a strong foundation and appreciation for the physics of heat transfer.

Program Objectives and Outcomes:

EML 4140 supports several educational objectives enumerated in the Mission Statement of the Department of Mechanical and Aerospace Engineering. Specific objectives supported by this course include 1) To understand and perform engineering analyses in the area of thermal systems, 2) To comprehend quantitative, analytical, and experimental methods, 3) To acquire the knowledge base, confidence, and mental discipline for self-education and a lifetime of learning.

Materials and Supply Fees: None

Professional Component (ABET):

EML 4140 supports several program outcomes enumerated in the Mission Statement of the Department of Mechanical and Aerospace Engineering. Specific ME program outcomes supported by this course include:

- (1) Using knowledge of chemistry and calculus-based physics with depth in at least one of them (ME Program Outcome M1);
- (2) Using knowledge of advanced mathematics through multivariate calculus and differential equations (ME Program Outcome M2);
- (3) Being able to work professionally in the thermal systems area (ME Program Outcome M4).

Mathematics	15%
Physical Sciences	15%
Engineering Science	70%

Relation to Program Outcomes (ABET):

Outcome
(a) Apply knowledge of mathematics, science, and engineering: Outcome (a), method of assessment is specially selected problems on three exams and homework.
(e) Identify, formulate, and solve engineering problems: Outcome (e), method of assessment is specially selected problems on three exams and homework.
(i) Recognize the need for, and engage in lifelong learning: Outcome (i), method of assessment is attending professional seminars on Heat Transfer and a comprehensive Final Exam
(k) Use the techniques, skills, and modern engineering tools necessary for engineering practice: Outcome (k), method of assessment is specially selected problems on three exams and homework

Required Textbooks and Software

T.L. BERGMAN, A.S. LAVINE, F.P. INCROPERA, & D.P. DEWITT, “Fundamentals of Heat and Mass Transfer,” 8th Edition, Wiley. This course is participating in UF All Access, which is a program designed to provide the most affordable option for students. <https://www.bsd.ufl.edu/G1C/bookstore/allaccess.asp>

- The required course material is delivered digitally through WileyPlus, containing a fully searchable etext and the required homework for this course. You may purchase an access code at a discounted price by going to this link:

<https://www.bsd.ufl.edu/G1C/bookstore/UFAllAccessInstructions.pdf>

This link authorizes the cost of the access code to be charged directly to your student financials account.

Course Outline: Below is an *approximate* list of topics that will be covered in this class. *Recorded lectures from Fall 2021 are posted for reference only. I hope that reviewing these lectures before class will allow students deeper understanding of the subject. For homework (check [Assignments link](#)).*

First unit: 6 Weeks (Conduction)

- [Introduction to heat transfer and rate laws](#)
- [Fourier’s Law and heat diffusion equation](#)
- [Rate equations and conservation of energy](#)
- [Introduction to conduction](#)

[One-dimensional steady-state conduction \(planar and cylindrical\)](#)
[Contact resistance and thermal circuits, heat generation](#)
[Heat transfer from extended surfaces](#)
[Two-dimensional steady-state heat transfer: Finite difference method, Gauss-Seidel Method](#)
[Energy Balance method for nodal equations and boundary nodes](#)
[Transient conduction, lumped capacitance method](#)
[Transient conduction, exact solutions and Heisler Charts](#)

Due Dates: Homework and Exam

1. Lecture 3 (**Thermo Pretest**) **1/12**
2. Lecture 6 **HW 1** **1/19**
3. Lecture 8 **HW 2** **1/26**
4. Lecture 11 **HW 3** **2/2**
5. Lecture 13 [Example problem](#) **2/7**
6. Lecture 15 [Sample Exam 1](#) **HW 4** **2/9**
7. **Exam on Conduction (2/16/23 5th period)** No class in 4th period

Reading material:

1. Chapters 1 and 2
Chapter 3 (omit 3.2)
Chapter 4 (omit 4.2, 4.3)
Chapter 5 (omit 5.8, 5.9)
2. [Practice Problems](#)
3. [Summary Notes](#)

Second unit: 4 Weeks (Convection)

[Introduction to convective transport processes](#)
[Introduction to boundary layers](#)
[Convective transport equations in differential form](#)
[Dimensionless variables and Reynolds analogy](#)
[Effects of turbulence](#)
[Introduction to external flow heat transfer](#)
[External flow heat transfer correlations](#)
[Introduction to internal flow heat transfer](#)
[Internal flow heat transfer coefficient and correlations](#)
[Introduction to natural convection](#)
[Introduction to phase change heat transfer](#)

Due Dates: Homework and Exam

1. Lecture 17
2. Lecture 18
3. Lecture 19 **HW 5** **2/23**
4. Lecture 20
5. Lecture 21
6. Lecture 22 **HW 6** **3/2**
7. Lecture 23
8. Lecture 24

9. Lecture 25 [Sample Exam 2 HW 7 3/9](#)
10. Lecture 26
11. **Exam on Convection (03/23/23 5th period)** No class in 4th period

Reading material:

1. Chapter 6 (omit 6.7 and 6.8)
Chapter 7 (omit 7.5 through 7.8)
Chapter 8 (omit 8.6 through 8.9)
Chapter 9 (9.1 - 9.3, plus things covered in class lectures)
Chapter 10 (follow class lecture)
2. [Practice Problems](#)
3. [Summary notes](#)

Third unit: 4 Weeks (Radiation)

[Introduction to radiation heat transfer exchange](#)
[Geometry, radiation intensity, emissive power](#)
[Irradiation and radiosity](#)
[Blackbody radiation exchange](#)
[Band emission](#)
[Emissivity, reflectivity, absorptivity, transmissivity](#)
[Kirchoff's Laws](#)
[Radiation view factors](#)
[Net radiation exchange among surfaces](#)
[Black body surfaces](#)
[Gray-Diffuse surfaces](#)

Due Dates: Homework and Exam

1. Lecture 27
2. Lecture 28
3. Lecture 29 HW 8 **3/30**
4. Lecture 30
5. Lecture 31
6. Lecture 32
7. Lecture 33 HW 9 **4/11**
8. Lecture 34
9. Lecture 35 Sample Exam 3 **4/13**
10. Lecture 36
11. Exam on Radiation (**04/20/23 5th period**) No class in 4th period
12. Lecture 37 HW 10 **4/25**

Reading material:

1. Chapter 12 (omit 12.9)
Chapter 13 (follow class lecture)
2. [Practice Problems](#)
3. [Summary Notes](#)

Additional Lectures

1. [Review Lecture Conduction](#)
2. [Review Lecture Convection](#)
3. [Review Lecture Radiation](#)

Assigned Homework (check [Assignments link](#)) Posted

Attendance and Expectations: Lecture attendance is imperative. Although attendance will not be taken or used in assigning grades, students will be held responsible for knowing all changes made to scheduling and all class announcements. There is a direct correlation between class attendance and class success. During class, cell phones must be turned off or muted. Don't bring food to class.

Note: Although information will be posted on the website, class announcement prevail in case there are discrepancies.

Assessment Methods:

Homework: Homework will be assigned throughout the semester. Homework will be graded. Homework will be due as indicated on the assignment. **Please submit your solutions ONLY via Canvas.** The HW problems may be downloaded from the course web site <https://lss.at.ufl.edu/> (use Canvas system).

Exams: There will be three midterm exams and one Final Exam during the semester in class. Will announce exam at least one week in advance. All exams will be cumulative but will emphasize the most recently covered material. The exams will be during the regular class period. Exams will be scheduled at the same day as the other section Heat Transfer with exception of Final. Each exam will primarily focus on specific chapters or major topics in the course. However, you may be required to understand and apply material from prior chapters in order to solve exam problems. Use of Chegg, CourseHero or other websites designed to provide live expert help on quizzes is cheating.

1. Exam I on the last class day of Week 6 - **02/16/23 5th Period**
2. Exam II on the last class day of Week 10 - **03/23/23 5th Period**
3. Exam III on the last class day of Week 14 - **04/20/23 5th Period**
4. **Final Exam as Scheduled 5/04/2023 @ 5:30 PM - 7:30 PM**
 - All exams are closed book. For the first 3 exams, you may bring in *1 sheet of paper* (8.5" x 11.5") with whatever notes you want on both the front and back. On the final exam, you may bring *3 sheets of paper* with notes on the front and back.
 - You should bring a basic working calculator and a pen (or a pencil) for all exams.
Show all work, clearly mark answers, and be neat.

Grading Rules:

The relative weighting of the HW Problems and Exams in the final grade will be:

- | | |
|-------------------------------|----------------|
| a. HW | 10% |
| b. 3 Midterm Exams | 60% (20% each) |
| c. Final Exam (Comprehensive) | 30% |

All exams are closed book. For the first 3 exams, you may bring in 1 sheet of paper (8.5" x 11.5") with whatever notes you want on both the front and back. On the final exam, you may bring 3 sheets of paper with notes on the front and back. NO collaboration is allowed during exams! If we must shift to virtual, this maybe amended.

In general, exams will closely follow homework problems in scope and complexity. Late assignments will not be accepted.

If a student feels that an exam or homework is graded unfairly, or if there is an error in the grading, please bring it to the instructor attention within a week after the graded material is handed back. Scores will not be reconsidered beyond the one-week period.

Grading Scale:

A 10-point scale (i.e. A>90%, B>80%, etc.) will be used as a baseline for final grades. An additional curve may be applied, as determined by the overall final grade distribution of the class. Intermediate grades will be determined at my discretion and are not based on a 5-point scale (e.g., 85%).

If you cannot attend an exam or cannot meet a due date, you must contact the instructor at least 1 week prior to the exam or due date. Failure to contact the instructor prior to the exam will result in a zero on that exam.

Arrangements will be made for students involved in conflicting official university activities.

Make-up Policy: No late assignments will be accepted. Make up exams are not normally allowed. If you cannot attend an exam or cannot meet a due date, you must contact the instructor at least 1 week prior to the exam or due date. Failure to contact the instructor prior to the exam will result in a zero on that exam. The only exception is sudden acute illness or an emergency. Arrangements will be made for students involved in conflicting official university activities.

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 feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/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://sccr.dso.ufl.edu/process/student-conduct-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 Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.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: <https://registrar.ufl.edu/ferpa.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 Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/state-authorization-status/#student-complaint>.