

## **Heat Transfer**

EML4140 Section 289F

**Class Periods:** M, period 7 (1:55 PM ~ 2:45 PM)

W, period 7 (1:55 PM ~ 2:45 PM)

F, period 7 (1:55 PM ~ 2:45 PM)

**Location:** TURL 011

**Academic Term:** Spring 2023

*It may become necessary to modify this syllabus during the semester.*

*In this event, students will be notified and the revised syllabus will be posted on the course web site.*

### **Instructor:**

Jing Pan

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352-294-6869

Office: Herbert Wertheim Laboratory for Engineering Excellence RM 485

Office Hours: M, 3:00 PM ~ 4:00 PM, In-person

W, 3:00 PM ~ 4:00 PM, In-person

F, 3:00 PM ~ 4:00 PM, In-person

### **Teaching Assistant/ Graders:**

Dylan McCord (TA)

[dylanmccord@ufl.edu](mailto:dylanmccord@ufl.edu)

904-881-2437

Office:

Office Hours: TBD

Israel Chinn (Grader)

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### **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**

MAP2302 with minimum grade C, EAS 4101 or EGN3353C

### **Course Objectives**

This course provides an intermediate level coverage of thermal transport processes via conduction, convection, and radiation heat transfer. It stresses fundamental engineering science principles applied to 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 solution techniques, coupled with a strong foundation and appreciation for the physics of heat transfer

### **Relation to Program Outcomes (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). Professional Component: Mathematical Sciences (15%), Physical Sciences (15%), Engineering Sciences (70%)  
 This course achieves the following ABET outcomes:

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Medium
3. An ability to communicate effectively with a range of audiences	
4. 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, economic, environmental, and societal contexts	Medium
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

### **Required Textbooks and Software**

- Fundamentals of Heat and Mass Transfer, T.L. Bergman, A.S. Lavine, F.P. Incropera, and D.P. DeWitt
- 7th or 8th Edition

### **Recommended Materials**

N/A

### **Course Schedule**

The lecture and assignments schedule is provided in page 7 of the syllabus.

### **Attendance**

Students are responsible for participating, staying up-to-date on all announcements, in-class lectures, posted video lectures, reading assignments and homework. Even though class attendance will not be used for assigning grades, it is extremely important that students attend the class regularly. There is direct correlation between class attendance and class success. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

### **Assignments**

**Reading:** The instructor will highlight the materials corresponding to a particular lecture. You are expected to do the reading before lectures.

**Homework:** Homework assignments will be posted online every week and will be due Wednesday the following week at midnight (11:59pm). All assignments should be submitted through Canvas. No email or hard copy submissions will be accepted. All problem solutions and grades will be posted on Canvas. There will be in total 12 homework assignments and the lowest score will be dropped. An example solution format is given at the end of the syllabus. Show all your work, clearly mark answers, and be neat.

**Late submission:** Late submissions will not be accepted. Only exceptions are rare instances (medical emergencies) with documentation and pre-approval by Dr. Pan.

### **Exams**

Midterm 1 – Feb. 15<sup>th</sup>, W, 7:00 PM to 8:30 PM;

Midterm 2 – Mar. 27<sup>th</sup>, M, 7:00 PM to 8:30 PM;

Final Exam – May. 4<sup>th</sup>, R, TURL 011 3:00 pm to 5:00 pm;

**Exam policy:** Exams are closed book. You can bring 1 sheet of paper (8.5" x 11.5") with your notes on both the front and back. If you cannot attend exams due to non-emergency events (e.g. conflicts with official university activities), you must contact the instructor 1 week prior to the exam and provide documentation. Make-up exams will only be given in rare instances (e.g. medical emergencies) with documentation and pre-approval by the instructor.

**Honorlock:** Consistent with University of Florida policy, Honorlock may be used for the mid-term exams and the final. Please see the following link: <https://distance.ufl.edu/proctoring/> for more information.

### **Evaluation of Grades**

Assignment	Percentage of Final Grade
Homework	20%
Midterm 1	25%
Midterm 2	25%
Final Exam	30%
Total	100%

**Grading policy:** Any re-grade requests must be submitted to Dr. Pan within a week after the grade is returned. Additional curves may be applied, as determined by the overall grade distribution of the class. Grade conversion will be based on the table below.

**Instructor credit:** Active participants in class discussion/office hours may receive 1~5% bonus instructor credit.

Percent	Grade	Points
90 - 100	A	4.00
85 - 89.9	A-	3.67
80 - 84.9	B	3.00
75 - 79.9	B-	2.67
70 - 74.9	C	2.00
65 - 69.9	C-	1.67
60 - 64.9	D	1.00
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

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

### **Notice of Copyright**

Materials in this course—unless otherwise indicated—are protected by United States copyright law [Title 17, U.S. Code]. Materials are presented in an educational context for personal use and study and should not be shared, distributed, or sold in print—or digitally—outside the course without permission.

### **Students Requiring Accommodations**

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, 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 Conduct 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. 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](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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](mailto:title-ix@ufl.edu), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto: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/>.

#### **COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.

- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

### 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://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**: <http://www.distance.ufl.edu/student-complaint-process>.

**EML 4140 Heat Transfer – Spring 2023**  
**Lecture & Assignments Schedule**

Week	Date	Lecture Topic	Ch.	Reading	HW Schedule
1	Jan. 9, M	(L01) Introduction: what is HT and relevance of HT	1	1.1, 1.6	HW1 available
1	Jan. 11, W	(L02) Introduction: rate equations and energy balance	1	1.2 - 1.5	
1	Jan. 13, F	(L03) Conduction 1: Fourier's law	2	2.1, 2.2	
2	Jan. 18, W	(L04) Conduction 2: heat diffusion equation	2	2.3, 3.4	HW2 available HW1 due
2	Jan. 20, F	(L05) Conduction 3: 1D s.s. HT in plane wall, thermal resistance	3	3.1	
3	Jan. 23, M	(L06) Conduction 4: 1D s.s. HT in radial system	3	3.2 – 3.4	HW3 available
3	Jan. 25, W	(L07) Conduction 5: 1D s.s. HT with heat generation	3	3.5	HW2 due
3	Jan. 27, F	(L08) Conduction 6: 1D s.s. HT in extended surface 1	3	3.6	
4	Jan. 30, M	(L09) Conduction 7: 1D s.s. HT in extended surface 2	3	3.6	HW4 available
4	Feb. 1, W	(L10) Conduction 8: 1D s.s. HT in extended surface 3	3	3.6	HW3 due
4	Feb. 3, F	(L11) Conduction 9: 2D s.s. conduction 1	4	4.1 - 4.3	
5	Feb. 6, M	(L12) Conduction 10: 2D s.s. conduction 2	4	4.4 - 4.6	
5	Feb. 8, W	(L13) Conduction 11: transient conduction 1 (lumped capacitance)	5	5.1	HW4 due
5	Feb. 10, F	(L14) Conduction 12: transient conduction 2 (Biot number)	5	5.2	
6	Feb. 13, M	(L15) Conduction 13: transient conduction 3 (spatial effect)		5.4 – 5.10	
6	Feb. 15, W	<b>Midterm exam 1</b>	1-5		
6	Feb. 17, F	(L16) Convection 1: boundary layer	6	6.1 – 6.3	
7	Feb. 20, M	(L17) Convection 2: convection governing equations	6	6.4	HW5 available
7	Feb. 22, W	(L18) Convection 3: similarity and dimension analysis	6	6.5, 6.6	
7	Feb. 24, F	(L19) Convection 4: external flow 1 (flat plate)	7	7.1 - 7.3	
8	Feb. 27, M	(L20) Convection 5: external flow 2 (other geometry)	7	7.3 – 7.6	HW6 available
8	Mar. 1, W	(L21) Convection 6: internal flow 1	8	8.1, 8.2	HW5 due
8	Mar. 3, F	(L22) Convection 7: internal flow 2	8	8.3	
9	Mar. 6, M	(L23) Convection 8: internal flow 3	8	8.4 – 8.7	HW7 available
9	Mar. 8, W	(L24) Convection 9: internal flow 4	8	8.4 – 8.7	HW6 due
9	Mar. 10, F	(L25) Convection 10: heat exchanger 1 (LMTD)	11	11.1 – 11.3	
10	Mar. 13~17	Spring Break			
11	Mar. 20, M	(L26) Convection 11: heat exchanger 2 (NTU)	11	11.4 – 11.6	
11	Mar. 22, W	(L27) Convection 12: phase change	10	10.1 – 10.5	HW7 due
11	Mar. 24, F	(L28) Convection 13: free convection	9	9.1 – 9.6	
12	Mar. 27, M	<b>Midterm exam 2</b>	6-11		
12	Mar. 29, W	(L29) Radiation 1: radiation basics	12	12.1, 12.2	HW8 available
12	Mar. 31, F	(L30) Radiation 2: radiation intensity	12	12.3	
13	Apr. 3, M	(L31) Radiation 3: blackbody radiation	12	12.4	HW9 available
13	Apr. 5, W	(L32) Radiation 4: real surface	12	12.5	HW8 due
13	Apr. 7, F	(L33) Radiation 5: absorption, reflection, transmission	12	12.6	
14	Apr. 10, M	(L34) Radiation 6: Kirchoff's law	12	12.7, 12.8	HW10 available
14	Apr. 12, W	(L35) Radiation 7: environmental radiation	12	12.9	HW9 due
14	Apr. 14, F	(L36) Radiation 8: view factor	13	13.1	
15	Apr. 17, M	(L37) Radiation 9: black surface HT	13	13.2	HW11 available
15	Apr. 19, W	(L38) Radiation 10: grey surface HT 1	13	13.3	HW10 due
15	Apr. 21, F	(L38) Radiation 11: grey surface HT 2	13	13.3	
16	Apr. 24, M	(L39) Radiation 11: multimode HT	13	13.4	
16	Apr. 26, W	(L40) Class Review			HW11 due
17	May. 4, R	<b>Final Exam</b>	1-13		

## HOME WORK SOLUTION EXAMPLE FORMAT

### **KNOWN:**

State concisely what is known about the problem.

### **FIND:**

State concisely what must be found.

### **SCHEMATIC:**

Draw a schematic of the physical system being considered. Label important variables. If application of the conservation laws is anticipated, represent the appropriate control volume or control surfaces by dashed lines. Be sure to identify processes associated with control volume/surfaces.

### **PROPERTIES:**

List the solid and/or fluid thermophysical properties used in your solution. Identify the table from the Text and especially the temperature at which the property was selected.

### **ASSUMPTIONS:**

It is important that you put all the assumptions in one place so that they can be reviewed. At the outset, some assumptions may be obvious, like “steady-state conditions,” etc. But as you begin to model more complicated systems, the assumptions are extremely important to the logic of your analysis.

### **ANALYSIS:**

Provide in sentence format, comments that make clear the logic and organization of your analysis. Be sure to identify by numbers any figures or equations taken from the Text.