Oakland University
School of Engineering and Computer Science

ME 4520/5520
THERMAL ENERGY TRANSPORT
Winter 2018 Syllabus

Instructor: Shixiang (Cici) Gao, Ph.D
Phone: (248) 507-4468
E-mail: **sgao@oakland.edu**

Office Hours: Tuesday: 4:00 PM-5:15 PM and Thursday: 4:00 PM-5:15 PM, EC 473
Other office hours are available by appointment.

Class Times: Tue and Thu 5:30PM –7:17PM, 206 EH

Textbook: **Fundamentals of Heat and Mass Transfer, 8th edition** by Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt, John Wiley & Sons

Course Prerequisites: ME 3500 (old ME 331) or equivalent

Course Website: The Moodle course management system will be used this semester. You may access the ME 4520/5520 website using your OUCA name and password at: https://moodle.oakland.edu. HW assignments, solutions, announcements, interesting web links and handouts can be found on this site. Please visit the website on a regular basis for course updates. Note: HW assignments will *not* be distributed in class.

Course Catalog Description:

ME 4520/5520 - Thermal Energy Transport (4): Continued study of properties and descriptions of conduction, convection and thermal radiation heat transfer; thermal boundary layer theory; forced and natural convection, heat transfer correlations. Thermodynamics of thermal radiation, radiation intensity, surface properties and energy exchange. Laboratory emphasizes experimental design and development of empirical relationships.

Course Objectives:

This is a senior/grad-level mechanical engineering course that is designed to further the students' understanding of the fundamental principles of heat transfer, beyond those covered at the introductory level (ME 3500 (old ME 331)). By the end of the course, the successful student will be able to:

1. Solve problems involving steady or transient conduction in one and multi-dimensional domains using exact analytical solutions and/or numerical methods. (a, e, k)
2. Apply the conservation of mass and energy and the momentum principle to obtain solutions for the convective heat transfer coefficient for forced or natural convection along a flat plate. (a, e, k)
3. Develop and use dimensionless correlations and property relationships in solving problems associated with convection heat transfer. (a, e, k)
4. Explain and model radiation intensity, irradiation and blackbody emissive power. Use the blackbody radiation function and spectral radiation properties to find average emissivity, transmissivity, and absorptivity properties needed to solve radiation heat exchange problems. (a, e, k)

5. Determine view factors and solve radiation exchange problems involving black or gray surfaces and within enclosures using the radiation network and direct approaches. (a, e, k)
6. Design and perform experiments or numerical simulations. Analyze data and write technical reports. (a, b, e, g, i, k)

Tentative Course Topics (Order subject to change):

Topic	Reading (Bergman):
Introduction; Review of heat transfer modes	1.1-1.7
Conduction heat transfer – the heat diffusion equation; boundary and initial conditions	2.1-2.5
One dimensional, steady state conduction – Exact solutions in planar and radial systems with and without thermal energy generation	3.1-3.5
Two-dimensional steady state conduction; Method of separation of variables; finite difference method	4.1-4.6
Transient Conduction – Exact solutions (lumped, general lumped capacitance analysis, spatial effects); Heisler charts	5.1-5.7
Convection heat transfer – Boundary layer equations; dimensionless parameters; Integral boundary layer equations (Von Karman method)	6.1-6.8; 7.1-7.2; Appendix G
Convection correlations – Natural convection and combined free and forced convection	9.1-9.9
Radiation heat transfer: processes and properties; radiation intensity; blackbody radiation; Kirchoff's law; gray surfaces	12.1-12.10
Radiation heat exchange between surfaces – View factors; radiation exchange in an enclosure; radiation shields	12.1-12.4; 13.1-13.7
Final Exam : Thursday, April 19, 2018 7:00PM – 10:00PM	

Homework:

➓ Homework is an indispensable part of this course. The principles and concepts introduced in this course can only be learned by practicing their application and solving multiple problems. Besides, the material on the quizzes and exams will be similar to the assigned problems!
➓ Homework will be assigned and collected weekly and will be spot graded at the instructor's discretion. Problem solutions should be presented neatly in a clear and logical fashion with assumptions, diagrams (when applicable), and analyses; final answers must be underlined or boxed. Homework will be discussed as needed, and solutions will be made available to students after the due date. Help is available before and after due dates. Keep a **Homework Log**, consisting of your homework problems in a **three-prong folder (please no binders or notebooks)**. The homework log will be reviewed by the instructor, and then returned to you.
➓ In-class homework short quizzes may also be administered periodically after a homework assignment due date.
➓ You are encouraged to consult with others on homework assignments and may opt to work in teams. Each student is, however, required to hand in his/her individual assignment with the names of students who provided assistance clearly indicated on the front page.
➓ **Copying homework solutions through any means is strictly prohibited. If any kind of copying behavior is found, zero points will be given for the homework and the assignment will be submitted to the Academic Conduct Committee for possible further action.**

Laboratory/Projects:

• Laboratory and project activities are intend to reinforce the fundamental concepts discussed in the lecture portion of the course. Laboratory or computational projects will be assigned relative to the availability of the lab equipment and the timing of lecture material. Generally, for each assignment, groups consisting of three or four students will be given approximately two weeks to conduct an experiment or complete a project and submit a report.
❿ Team members will have the opportunity to evaluate the performance and contribution of fellow team-members through periodic team evaluations. An individual student's cumulative laboratory/project grade will be adjusted at the end of the course by up to ±20% based on these evaluations.

Exams:

There will be about three tests given during the semester, and a cumulative, three-hour final exam at the end of the term. Short in-class 2-5 minute connect quizzes may also be randomly given during class and will be included in the **Class attendance and short quizzes** grade. When necessary, you will be provided with a formula sheet during certain exams. NO other materials such as class notes, textbook, homework sets, or old exams will be allowed during the tests. Cellular phones and pagers are also prohibited during tests. If you miss a test without either a valid medical excuse or prior instructor approval, you will be assigned a grade of zero on the test. You may be given the option of taking a makeup test at the instructor's discretion. **Students requiring special arrangements for tests should notify the instructor of the needed accommodations (along with letter from DSS office) at the beginning of the semester.**

Please note that ME 5520 students may be required to complete additional assignments or projects.

Tentative Test Schedule (Subject to change):

Test #1:	January 30, 2018
Test #2:	March 1, 2018
Test #3:	April 3, 2018
Final Exam:	April 19, 2018

Grading: The course grade will be calculated as follows:

Tests:	50%
Final Exam:	25%
Laboratory/projects:	15%
Homework:	5%
Class attendance and short quizzes	5%

It is possible for every student to obtain an A for the course. Significant improvement or decline in student performance throughout the semester will be taken into account in determining the course grade. If the final exam score increases significantly (i.e., 10 points or more above) from the exam average, the final exam weighting will be increased to 30% and the test weighting will be decreased to 45% when determining the course grade. There is no fixed grading scale for this course; a conversion formula from your percentage score to Oakland University grades will be determined at the end of the course. However, the following "standard scale" shows the lowest possible grade that a given percentage score will generally earn (the grade may be higher than this): 95%→4.0, 80%→3.0, 68%→2.0, 50%→0.0. Note that an average of 50 or less will always be considered as a failing grade, 0.0.

Important Dates:

- February 19 – 25 – Winter recess (no class)

- April 17 - Last ME 448/548 class
- April 19 **- Final Examination** –7:00PM – 10:00PM
- Other important semester dates can be accessed at http://www.oakland.edu/important-dates

Academic Conduct:

Students are expected to read, understand and comply with the Academic Conduct Policy of Oakland University, as explained at http://www.oakland.edu/studentcodeofconduct. Violations will be taken before the Academic Conduct Committee. Students found guilty of academic misconduct in this course will receive a grade of 0.0 in addition to any penalties imposed by the Academic Conduct Committee. The latest version of the Academic Conduct Committee's procedures is in the Dean's office. Students caught, for example, cheating on lab reports (by copying from old lab reports), quizzes, or communicating with each other during a test will be dealt with aggressively. A student caught helping another student cheat (for e.g., by allowing him/her to copy off an exam) will dealt with just as aggressively as the student caught cheating.

Please note that **the use of cell phones, text messaging and laptops** is not allowed in this class unless you receive a special dispensation from the instructor.

Program Outcomes: ABET 3 (a-k)

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environ., social, political, ethical, health, safety, manufactured ability, sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global economical, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice