Oakland University
School of Engineering and Computer Science

EGR2500-008: Introduction to Thermal Engineering
Winter 2018 Syllabus

Instructor:	Dan DelVescovo Ph.D., Asst. Professor, Mechanical Engineering 414 EC, (248) 370-4590 E-mail: delvescovo@oakland.edu
Office Hours:	T: 12:15pm – 1:15pm; (Alternative office hours are available by appointment)
Class Times:	TR: 10:00am – 11:47pm, 203 Dodge Hall (DH)
Laboratory Times:	M: 10:00am – 11:47am, R: 1:00pm – 2:47pm, R: 3:00pm – 5:00pm (356 EC)
TA:	Yu Liu, E-mail: yuliu2@oakland.edu, Office Hours: MW 1:30 – 3:30 (401 EC)
Textbook:	Fundamentals of Thermal-Fluid Sciences, 5th edition, Yunus A. Cengel, John M. Cimbala, Robert H. Turner, McGraw-Hill
Course Prerequisites:	[(CHM 143 or CHM 1430) or (CHM 144 or CHM 1440) or (CHM 157)], (PHY 161 or PHY 1610) or (PHY 151 or PHY 1510), and (EGR 141 or 1400); pre/corequisite: (APM 255 or APM 2555)
Course Website:	The Moodle course management system will be used this semester. You may access the EGR2500 course website using your OUCA name and password at: https://moodle.oakland.edu. HW assignments, solutions, important announcements, and handouts can be found on this site. Please visit the course website regularly for course updates.
McGraw-Hill Connect (Online HW)	http://connect.mheducation.com/class/d-delvescovo-smartstart-course Tech Support Help: (800) 331-5094

University Catalog Description:

EGR 2500 - Introduction to Thermal Engineering (4 credits): Introduction to the fundamentals of classical thermodynamics and heat transfer; first and second laws of thermodynamics; thermodynamic property relationships; application to engineering systems and processes; introduction to conduction, convection and radiation; steady 1-D conduction and extended surfaces; lumped capacitance method. Offered fall and winter.

General Education Student Learning Outcomes:

This course will satisfy the Oakland University Natural Science and Technology general education requirement. As such, students will demonstrate:

1. knowledge of major concepts from natural science or technology, including developing and testing of hypotheses, drawing conclusions, and reporting of findings and some laboratory experience or an effective substitute
2. how to evaluate sources of information in science or technology

General Education Cross Cutting Capacities:

- Effective Communication
- Critical Thinking

ABET Course Objectives:

The primary objectives of this course are to teach the fundamental concepts, principles and engineering applications of classical thermodynamics and to introduce the rate equations and physical mechanisms associated with heat transfer. The laboratory component is intended to reinforce these basic concepts, teach principles of experimentation and experiment design, and improve teamwork and communication skills. An additional goal of the course is to assist the student in developing the ability to analyze and solve engineering problems using logical reasoning and mathematical principles. By the end of the course, the successful student will be able to:

1. List and describe relevant thermodynamic terminology related to thermodynamic systems and properties. Demonstrate proficiency in performing unit conversions. (a)
2. Design and perform experiments. Formulate, evaluate and calculate experimental uncertainties of indirect measurements. Analyze experimental data and write technical reports. (b, d, f, g, i, k)
3. Interpret thermodynamic property tables and graphs. Calculate property values, and apply to various thermodynamic systems and equations of state. (a, e)
4. Explain and apply the Conservation of Energy and the Conservation of Mass Principles to a variety of open and closed thermodynamic systems such as nozzles, turbines, throttling valves, heat exchangers, refrigeration systems, vapor cycle power plants. (a, e, k)
5. Explain and apply the Second Law of Thermodynamics to a variety of thermodynamic processes and to model a variety of open and closed thermodynamic systems. Describe its implications and influences. (a, e, k)
6. Describe the physical mechanisms associated with the three fundamental heat transfer modes. (a)
7. Apply the concepts of one-dimensional steady conduction to the solution of problems involving plane, curved and composite walls; use the thermal resistance concept to model and solve thermal network problems. (a, e, k)
8. Evaluate the steady rate of heat transfer, efficiency and effectiveness of finned surfaces (a, e, k)
9. Formulate and apply the lumped capacitance method for the solution of transient heat transfer problems. (a, e, k)

Course Topics: *(Order subject to change)*

Week	**Date**	**Topics Covered** (Tentative)	**Reading**
1	1/4	Course Intro/Mechanics, dimensions and units	1.1 – 1.5
2	1/9	Basic Concepts: continuum, open/closed systems, intensive/extensive props, process/cycle, density, thermodynamic state	2.1 – 2.5
	1/11	Temperature and the Zeroth Law of Thermodynamics, pressure and pressure measurement devices	2.6 – 2.8
3	1/16	Energy and Energy Transfer, Heat, Work, mechanical work	3.1 – 3.5

	1/18	First Law of Thermodynamics, energy conversion and efficiency	3.6 – 3.7
4	1/23	First Law Examples and Test #1 Review	
	1/25	***Test #1***	***Chapters 1 – 3***
5	1/30	Properties of pure substances, phase change, property diagrams for phase change processes	4.1 – 4.4
	2/1	Property tables, interpolation, internal energy, enthalpy, and specific heats	4.5
6	2/6	Ideal gas law, incompressible substances, equations of state	4.6 – 4.7
	2/8	Energy analysis of closed systems, evaluating u and h for ideal gases, moving boundary work	5.1 – 5.5
7	2/13	Conservation of mass and energy for control volumes, flow work, energy analysis of steady flow systems	6.1 – 6.3
	2/15	Application of conservation of mass and energy to steady-flow devices (nozzles, diffusers, turbines, pumps, etc)	6.4
8	***2/17-2/25***	***Winter Recess***	
9	2/27	Steady Flow Device Examples and Test #2 Review	6.4
	3/1	***Test #2***	***Chapters 4 – 6***
10	3/6	Heat transfer mechanisms, conduction, convection, radiation, and simultaneous heat transfer mechanisms	16.1 – 16.5
	3/8	Steady heat conduction, thermal resistance, and thermal resistance networks	17.1 – 17.3
11	3/13	Heat conduction in cylinders and spheres, critical radius of insulation	17.4 – 17.5
	3/15	Heat transfer from finned surfaces, fin efficiency and fin effectiveness, fin arrays	17.6
12	3/20	Fin Examples and Transient Heat Transfer (Lumped Capacitance method)	18.1
	3/22	Fin Example Problems and Test #3 Review	
13	***3/27***	***Test #3***	***Chapters 16 – 18.1***
	3/29	Second Law of Thermodynamics, cycle efficiency and coefficient of performance, heat engines, refrigerators, and heat pumps	7.1 – 7.4
14	4/3	Reversible and irreversible processes, Carnot cycle	7.5 – 7.11
	4/5	Entropy, entropy change, isentropic processes	8.1 – 8.4
15	4/10	Property diagrams, Tds relations, entropy change of liquids, solids and ideal gases (SAE WC)	8.5 – 8.9
	4/12	Reversible work, isentropic efficiency of steady flow devices (nozzles, pumps, compressors, turbines) (SAE WC)	8.10 – 8.12
16	4/17	Entropy balance and Example Problems (Final Exam Review)	
17	***4/19***	***Final Exam (8:00am – 11:00am)***	***Chapters 1 – 11.1***

Homework:

- 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. The material on the exams will be ***similar*** to the assigned problems (though not necessarily identical), and a complete and practiced understanding of the material is necessary to do well in the course.
- ***Online homework*** will be assigned weekly through ***McGraw Hill Connect***, and will be comprised of 5-12 problems.
- In addition to online homework submissions, students will be required to turn in a copy of their work on each problem (i.e. equations, algebraic steps, assumptions, etc…). The following is a list of formatting and submission guidelines for these homework submissions. Deviation from these guidelines may result in a grade of 0 for the assignment.
    - Solutions must be ***neatly*** prepared on loose-leaf or engineering paper; i.e. spiral notebook paper with frayed edges will ***not*** be accepted.
    - Assumptions, diagrams (when applicable), and analyses should be presented in a clear and logical fashion.
    - Final answers must be underlined or boxed.
    - All pages should be numbered and stapled together.
    - Homework is due at the beginning of class.
    - Late submissions will not be accepted without approval from the instructor.

- 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. Failure to give proper credit for assistance received will be considered plagiarism and will be dealt with in accordance with university policies.
- **Copying homework solutions from a solution manual or from solutions found online or through other means is strictly prohibited.**

Laboratory:

- There will be four laboratory experiments beginning the week of January 8^{th}, 2017 in room 356 EC. The laboratory is an integral part of the course and allows students to both witness and apply the fundamental concepts and principles being studied in class.
- Students are required to register for one lab section, which will meet every week for about 1-1.5 hours. Lab time will be used about every other week to demonstrate the experiment and cover relevant background information. Instructions, handouts, and other information will be provided at that time. On alternating weeks, lab lecture time might be used to supplement the course material with such things as MS-Excel demos, as well as example problems.
- Students will perform the lab experiments in teams of ***four***. Teams of three may be allowed under certain circumstances and require instructor approval. If possible, teams should include at least one member from a different major to provide multi-disciplinary team experience. You will select the people in your team.
- Teams will schedule a time to conduct the experiments using a sign-up sheet posted on the lab door by the lab teaching assistant. Most labs can be completed in two hours or less. A team lab report is usually due within ~two weeks of the lab assignment and must follow the **lab report guidelines**. Lab reports are to be submitted as word documents via email to the instructor and the TA by 11:59PM on the **Saturday** that they are due. Failure to turn in a lab report may result in a failing course grade. **In order to pass this course, *students must pass the laboratory portion.***
- Team members will have the opportunity to evaluate the performance and contribution of fellow team-members for each lab. An individual student's cumulative laboratory grade will be adjusted at

the end of the course based on individual contribution to the lab assignments, as well as based on these evaluations. If repeated efforts to improve team functioning (including faculty intervention) fail, a non-participant may be fired by unanimous consent of the rest of the team, and a team member doing essentially all the work may quit. This however requires prior instructor approval. Individuals who quit or are fired must find a team of three unanimously willing to accept them; otherwise they will receive zeros for the remainder of the labs.

- The instructor reserves the right to adjust the grade of any lab based on the written communication skills demonstrated in the lab report. A poorly written lab can lose up to half the total possible points.

Tentative Lab Schedule:

Laboratory Assignment	**Introduced (Week of)**	**Report Due (Sat. 11:59pm)**
Lab 0 – Introduction and Uncertainty Analysis	1/8	1/20
Lab 1 – Flowrate Measurement and Calibration	1/22	2/10
Lab 2 – Measuring the Energy Content of Food	2/5	3/3
Lab 3 – Modeling an Electric Water Heater	2/26	3/17
Lab 4 – Refrigeration/Heat Pump Systems	3/12	3/31

Exams:

There will be three in-class tests given during the semester, and a cumulative, three-hour final exam at the end of the term. 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. Cell 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. In-class 15-25 minute quizzes may also be randomly given during class. **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.**

Tentative Exam Schedule (Subject to Change):

Test Number	**Textbook Chapters**	**Date**
Test #1	1-3	1/25/17
Test #2	4-6	3/1/17
Test #3	16-18	3/29/17
Final Exam	1-8, 16-18	4/19/17

Grading:

The course grade will be calculated as follows:

Total	**100%**	**2000 points**
Tests (3 total, 12.5% each)	*37.5%*	*750 (250 each)*
Final Exam	*25%*	*500*
Laboratory	*21%*	*420*
In-Class Quizzes	*4%*	*80*
Homework	*10%*	*200*
Participation	*2.5%*	*50*

Grade	**~Minimum %**
4.0	*93%*
3.5	*87%*
3.0	*81%*
2.5	*75%*
2.0	*69%*
1.5	*63%*
1.0	*57%*
0.0	*<50%*

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. The above "standard scale" shows the lowest possible grade that a given percentage score will ***generally*** earn (this scale is subject to change, however a grade of less than 50% will ***ALWAYS*** result in a grade of 0.0 for the course).

Important Dates:

- January 15th – Martin Luther King Jr. Day, No Classes
- January 17th – Last day for "no-grade" drop and last day for 100% semester refund
- February 17th to 25th – No classes (Winter Recess)
- March 14th – Last day for official withdrawal (W)
- April 17th – Winter classes end at 10:00PM
- April 19 – **Final Examination** – 8am to 11am (DH203)

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 if a proctor happens to step out of the room, 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 be 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.

Student 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