ME 3500: INTRODUCTION TO FLUID AND THERMAL ENERGY TRANSPORT

Syllabus and Course Policies

Instructor: Xia Wang, Ph.D., Professor
Office: 406 EC
Phone: 248-370-2224
FAX: 248-370-4416
Email: wang@oakland.edu

Office Hours: Tuesday 3:00pm-4:00pm, after class/lab, or by appointment.

Class Times: Thuesday and Thursday, 1:00pm-2:47pm, Dodge Hall 200
Lab Times: Tuesday, 10:00am-11:00am or Thursday, 3:00pm-4:00pm, EC 360

Teaching Assistants: Meng Xu, mxu@oakland.edu

Course Web Site: http://moodle.oakland.edu
(note: HW assignments, solutions, 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.)

Required Textbooks:

1) Introduction to Fluid Mechanics, R.W. Fox and A.T. McDonald, 9th John Wiley **with Wiley Plus account.**
2) Introduction to Thermal Dynamics and Heat Transfer, Cengel, 2th McGraw Hill
or Fundamentals of Thermal and Fluids Sciences, Cengel, 5th, Mc.Graw Hill

Course Prerequisites:
EGR 250 (with grade of 2.0 or higher) and MTH 254; pre/co-requisite: EGR 280

Course Objectives:

The primary objective of this course is to teach the fundamental concepts and engineering applications of fluid mechanics and 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 this 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 this course, the successful student will be able to:

1. List and define elementary terminology related to fluid flow and heat transfer; explain the different flow classifications and flow field descriptions. Describe the different mechanisms of heat transfer and the different regimes of fluid flow. (a)
2. Design and perform experiments. Formulate, evaluate, and calculate experimental uncertainties of indirect measurements. Analyze experimental data and write quality technical reports. (b, d, f, g, i, k)
3. Explain the integral form of the conservation of mass and momentum principles and apply to a variety of static and dynamic fluid problems. (a, e, k)

4. Describe the development of the Bernoulli and Euler's equations for inviscid flows and list the underlying assumptions; apply the Bernoulli equation to appropriate engineering problems. (a, e, k)
5. Describe the meaning and the physical significance of the continuity and Navier-Stokes equations. (a)
6. Derive the velocity profile in a simple laminar viscous flow; explain viscous drag and the role of the Reynolds number in distinguishing between laminar and turbulent flows; evaluate the head loss and pressure drop in single-path piping systems. (a, e, k)
7. Use the heat diffusion equation with appropriate boundary conditions to determine a steady one-dimensional temperature distribution in a solid. (a, e, k)
8. Describe viscous and thermal boundary layers; select and apply suitable empirical convection correlations to determine the convective heat transfer coefficients for simple engineering geometries. (a, e, k)
9. Use convection correlations to evaluate the overall heat transfer coefficient in problems involving convection and conduction such as heat exchangers. (a, e, k)

Tentative Course Calendar:

Week of	Topics	Suggested Reading Chapters
Jan 4	Syllabus/ Introduction of Fluid/Unit	Fox & McdDonald: 1.1-1.7, 2.1-2.2
Jan 8	Velocity Field; Stress Field, viscosity, Boundary Layer Hydrostatics	2.3-2.7 3.1-3.4, 3.6
Jan 15	Integral Form equation, Mass and Momentum conservation	4.1-4.4.4
Jan 22	Differential Form Equation, Flow Motions	5.1, 5.3-5.4
Jan 29	Bernoulli Equation; Static, Stagnation, Total pressure	6.1-6.4, 6.61
Feb 05-Feb 12	Internal Flow: Pipe flow and Ducts Flow	8.1-8.3
Feb 26	External Flow: Boundary layer flow	8.4-8.8
		Cengel
March 5	Review of heat transfer concepts	9.1-9.5 and 10-1 -10.7
March 12	Heat Equation	Notes
March 19	Convection Heat Transfer-External Flow	12
March 26	Convection Heat Transfer-External Flow	12
April 2	Convection Heat transfer-Internal Flow Convection heat transfer-Internal Flow	13
April 9	Heat Exchanger Design	16
April 24	12:00-3:00pm	Final Exam

Laboratory Schedule (Tentative):

Laboratory Schedule			
		Introduced:	**Due Date:**
Lab #1	Measuring Oil Viscosity	Jan 15	Feb 3
Lab #2	Impact of a Fluid Jet	Jan 29	Feb 17
Lab #3	Bernoulli Equation Demonstration	Feb 26	Mar 17
Lab #4	Design Experiment	Mar 12	April 17

Course Grade:

Laboratory	**20 %**
Homework	**5 % (2%+3%)**
In class activity	**3 %**
Quizzes	**37 %**
Final Exam	**35 %**
Total	**100%**

Important Dates:

- January 3rd - Classes begin.
- January 15th - Martin Luther King ,Jr. Day (No Class)
- January 17th – Last day for 100% tuition refund
- Feb 18-Feb 25 – No class (Spring break)
- April 2 - Last Day Official Withdrawl
- April 17 - Winter classes end 10:00pm
- April 24 - Tuesday, 12:00pm-3:00pm, Final Exam

Some Course Policies

Homework:

a) Homework will be assigned and collected every week. Only randomly chosen problems will be graded. You may wish to retain a copy of your homework solution to compare with the posted solution prior to your work being returned to you. Help is available before and after due dates.

b) Use any neat 81/2 × 11 paper, neatly written or typed on one side, beginning each new problem with a dividing line. The completed assignment should be stapled together (no binders or clips or folders). You may want to make a copy of all assignments before submission.

c) Collaboration on homework should be limited to general discussion of the problems and approaches. Copying homework and solution manual is NOT allowed. If any kind of copying behavior is found, you will receive zero for the homework.

d) One of the lowest homework grades will be dropped when calculating the cumulative grade for homework.

Activities: Some activities will be assigned in the class, and then collected by the instructor at the end of the class. Student should prepare a piece of paper for the in-class activities. Activities will be randomly graded. NO LATE ACTIVITIES WILL BE ACCEPTED.

Quizzes:

a) Exam dates and times are given in the class calendar. (one week ahead of time)

b) All exams will be **closed notes and closed book**. Formula sheets may be provided with some of the exams. Only non-graphic calculator is allowed to be used for all exams.

c) A score of zero will be recorded for a missed exam. Make-up exams will be given only by prior arrangement, or for a documented illness or serious emergency.

Laboratory: The laboratory will begin the *third week* of class. Details regarding the operation of the lab, laboratory reports and a schedule will be given during the first lab meeting. **In order to pass this course, students must pass the laboratory portion**.

Academic Conduct: All students are expected to read, understand, and comply with the *Academic Conduct Policy* found in the *Oakland University Undergraduate Catalog*. (*http://catalog.oakland.edu/content.php?catoid=29&navoid=2996#Other_Academic_Policies*). It may also be found on the OU website at https://www.oakland.edu/deanofstudents/conduct-regulations/. The policy applies to testing, homework and laboratory work, and is taken very seriously by the instructor. Perceived violations of this policy will be taken before the OU Academic Conduct Committee. Engineering is a profession that serves the public and demands integrity within its membership.

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