ME 20000 Thermodynamics, 3 credits

General course information

- **Instructor:** Dr. Huidan (Whitney) Yu
  Tel: 317-2783410
  Office: SL 260Q, IUPUI campus
- **Class meeting:** Lecture: TR 3:50 – 5:05 PM, JH 303, Butler campus
  Recitation: TR 5:10 – 5:35 PM, JH 303, Butler campus
- **Office Hours:** Thursday 3:00 - 3:40pm, JH 253B, Butler campus
  Per Canvas request
- **Textbook:** *Fundamentals of Engineering Thermodynamics*, M.J. Moran, H.N. Shapiro, D. D. Boettner, and M. B. Bailey, Eighth Edition, Wiley, 2014.
  Note: Engineering Software Package programs is not used in this course, thus no need to buy it.

Specific course information

- **Catalog description**: Basic concepts of thermodynamics for closed systems and control volumes. Property evaluation of ideal gases and compressible substances. Fundamental Theory and preliminary applications of the first and second laws of thermodynamics. Entropy and Carnot efficiency.
- **Prerequisites:** *PHY 152*, *MATH 261* or equivalent. The material in ME 20000 is based on the understanding of (1) calculus including ordinary/partial differentiation and integration and (2) general physics including concepts of work, heat transfer, and energy, etc. and mass/energy conservation laws
- **Required, elective, or selected elective course:** Required

Specific goals for the course

- **Outcomes of instruction**
  i. Basic concepts
     - Students can identify control volumes, closed systems, and transient systems
     - Students can apply the state principle
     - Students can identify intensive and extensive properties
     - Students understand the concept of equilibrium
     - Students can apply conservation of mass

  ii. Property evaluation
     - Students can recognize three types of substances: ideal gas, compressible substance, incompressible substance
     - Students can use tables to evaluate the properties of compressible substances, including identifying the phase of the substance
     - Students can use tables to evaluate the properties of ideal gases
     - Students can use equations to evaluate the properties of compressible substances

  iii. First Law analysis
     - Students understand the principles of work and heat
     - Students can calculate boundary work for a system from $\int PdV$
     - Students understand the conservation of energy
     - Students can apply the first law to closed systems
     - Students can apply the first law to control volume systems

  iv. Second Law analysis

- Students understand and can calculate the thermal efficiency for a heat engine and the coefficient of performance for a refrigerator and heat pump
- Students understand the connection between the Clasius statement and the Kelvin-Planck statement, and the second law
- Students understand the concept of reversibility
- Students understand the principle of the Carnot cycle and can make calculations of Carnot thermal efficiency and Carnot coefficient of performance
- Students understand the entropy property and can evaluate it for different types of substances
- Students can calculate and interpret the entropy change of the universe for a process
- Students can apply isentropic efficiencies for control volume work devices

v. Analysis of thermodynamic systems
- Students can perform calculations for power cycle
- Students can perform calculations for heat pump and refrigeration cycles

vi. Overall objectives
- Students have developed skills necessary for a systematic approach to problem solving in real world thermodynamic systems
- Students can solve a range of thermodynamics problems that include combinations of the individual objectives listed.

- **ABET student outcomes addressed by the course**
  (a) Apply math, science & engineering
  (e) Identify, formulate, and solve engineering problems
  (i) Life-long learning
  (k) modern engineering tools.

Topics covered

- A systematic problem-solving approach for solving thermodynamics problems
- Basic concepts of systems, properties, conservation of mass, and equilibrium
- Property evaluation for ideal gases
- Property evaluation for non-ideal-gases substances
- Application of the first law of thermodynamics for closed systems and control volume
- Application of the second law of thermodynamics for closed systems and control volume
- Analysis of cycles
- Analysis of thermal systems

Course evaluation

Homework sets…….. (25%)
In-class Quizzes…… (10%)
1st In-class Exams……..…. (20%)
2nd In-class Exams……..….(20%)
Final exam…….. (25%)

- **Canvas** is the designated platform for entire course-related communication outside of lectures and office hours — http://canvas.iu.edu. It is noted that
  i. All the information and materials will be accessed on this system throughout the semester including messages and announcements, syllabus and course

schedule, supplementary handouts, HW and project assignments, grades, and so on.

ii. Students are required to send course related messages through Canvas/Inbox to Instructor and TA concurrently to ensure quick responses.

iii. Students are responsible to set up notifications on Canvas and check their emails as well as the course web site on Canvas time accordingly for any course information.

iv. Students are encouraged to discuss course issues on Canvas/Discussion.

v. Course grade scale will follow the Latter Grades with +/- on Canvas as

Name:	Range:	
A+	100%	to 97.0%
A	< 97.0%	to 93.0%
A-	< 93.0%	to 90.0%
B+	< 90.0%	to 87.0%
B	< 87.0%	to 83.0%
B-	< 83.0%	to 80.0%
C+	< 80.0%	to 77.0%
C	< 77.0%	to 73.0%
C-	< 73.0%	to 70.0%
D+	< 70.0%	to 67.0%
D	< 67.0%	to 63.0%
D-	< 63.0%	to 60.0%
F	< 60.0%	to 0.0%

Grade upgrade request based on personal expectation/imagination or special needs will not be issued.

- **Homework** (HW) is due every 1-2 weeks (based on the lecturing pace) on Canvas. Each HW is required to submitted electronically and then graded on Canvas. Students are responsible for high quality scanning copies with PDF format. If the HW has to be returned because of the non-readable quality such as non-PDF format, $90^0/180^0$ rotated layout, too light to be recognized, etc., the HW will be requested for rescanning and re-uploading but 10% of the HW points will be subjected. Late HW will cause penalty, 10% of the HW points off per late day. Once the HW grading is completed, no re-uploading or late HW is accepted.
- A **systematic approach of solving thermodynamics problems** is required to use for all the problem solving in HW and exams in this course, unless otherwise indicated, and corresponding grading policy is regulated.
- In-class **quizzes** will be given throughout the course at the discretion of the instructor without prior notice.
- All **exams** are closed book and closed notes but equation sheet, tables, and graphs will be provided when needed. There will be 70 minutes for in-class exams and 2 hours for final exam. Format of exam will be announced one week before the exam day.
- There will be **NO MAKEUP** quizzes and exams. On rare occasion that a student is excused for emergency or a prior approval for non-emergency, the missed credit will be obtained. The instructor reserves the right to decide how to credit based on specific cases. Both emergency and non-emergency excuses require **valid written documents**.

Important policy notes

- Students should not enroll in the course unless they have met the prerequisite requirements.
- Students are required to show appropriate behaviors in the classroom. During class all electronic devices such as phone, pad, and laptop should be muted and appropriated stored

unless required. Food and drinks should not be consumed. Any student who is found to be a distraction to the instructor or other students will be dismissed immediately.

- Students are aware of the statements made regarding cheating in the IUPUI "Student Rights and Responsibilities" booklet. Such academic misconduct will be handled according to the guidelines in that booklet. Penalties for such misconduct include lowering of a student's grade as well as dismissal from school. A quote from the above mentioned booklet is worthwhile. "It is the responsibility of the student not only to abstain from cheating but, in addition, to guard against making it possible for others to cheat. Any student who helps another student to cheat is as guilty of cheating as the student he/she assists." Website for student code of conduct: http://www.iu.edu/~code/code/index.shtml.
- If any students need any special accommodations or assistance due to a disability, please contact **Adaptive Educational Services (AES)** at (317)-274-3241. The office is located in Joseph T. Taylor Hall (UC), Room 100. AES website: http://aes.iupui.edu/services.html. No qualified individual with a disability shall, by reason of such disability, be either excluded from participation in or be denied the benefits of the services, programs, or activities" of Indiana University-Purdue University Indianapolis."

Couse Schedule

- The following schedule is tentative and will be subjected to modify or change with or without prior notice
- If conflict date/time between this schedule and Canvas assignment is seen, students should follow the canvas assignment.

	Topics	Recitation	Due
1	Syllabus and introduction	No	
	Ch1. Fundamental concepts	No	
2	Ch1. Units and Unit conversion	Yes	
	Ch1. Problem-solving methodology	Yes	HW #1
3	Ch2. Understanding of work and heat transfer	Yes	
	Ch2 Energy balance for closed systems	Yes	HW #2
4	Ch2 Energy analysis of cycles	Yes	
	Ch3 p-v-T relations and phase change	Yes	HW #3
5	Ch3 Evaluation of properties and its applications	Yes	
	Ch3 Generalized compressibility chart	Yes	HW #4
6	Ch3 Idea gas model and Polytropic process	Yes	
	Review (Ch1-3)	Yes	HW #5
7	1st In class exam (Ch1-3)	No	
	Ch4 Mass and energy rate balance	Yes	
8	Ch4 Analyzing control volume and system integration	Yes	
	Ch4 System Integration	Yes	HW #6
9	Spring break, No class	No	
	Spring break, No class	No	
10	Ch5 Second law and its statements		
	Ch5 Reversible and irreversible processes	Yes	
11	Ch5 Second law aspects of power/refrigeration/Heat pump cycles		HW #7

	Ch5 Carnot Cycle and Clausius inequality	Yes	
12	Review (Ch4-5)		HW #8
	2nd In class exam (Ch4-5)	No	
13	Ch6 Entropy and data		
	Ch6 Entropy balance in closed system	Yes	
14	Ch6 Entropy rate balance for control volume		HW #9
	Ch8-9 Steam Power and gas power systems	Yes	
15	Ch10 Refrigeration and heat pump systems		
	Review (Ch 1-6 and 8)	No	HW #10
Final Exam (Ch 1-6 and 8-10)			