Texas A&M University- Corpus Christi
School of Engineering and Computing Sciences
Thermodynamics ENTC 3420-201- Spring 2014

Instructor: Andrew Conkey PhD
Office: EN 219  Phone: 825-2559
Email: andrew.conkey@tamucc.edu
Lectures: TR EN 108  5:00-6:15PM  Credit hours
Office Hours: TBD, by appointment too

Course Description:
Theory and application of energy methods in engineering; conservation of mass and energy; energy transfer by heat, work and mass; thermodynamic properties; analysis of open and closed systems; the second law of thermodynamics and entropy; gas, vapor and refrigeration cycles.
Prerequisites: PHYS 2425 - University Physics I and MATH 2414 - Calculus II

The objectives of this course are
➢ To cover the basic principles of thermodynamics
➢ To present sufficient engineering examples to give students a feel for how thermodynamics is applied in engineering practice
➢ The course will cover the following topics (Chapters 1 to 7, and 9 to 11 of the Textbook):
    ➢ Basic concepts of thermodynamic system
      • System, state variables, and properties of gases and liquids
      • First law of thermodynamics and how to apply it to thermodynamic systems
      • Second law of thermodynamics and Entropy
      • Work and heat exchange during reversible or irreversible processes
      • Analysis of the rated power and performance of gas power and vapor and combined cycles, such as internal combustion engines, gas turbines, power plants and refrigerators

Textbook:

The media package for this text is extensive, giving users a large variety of supplemental resources to choose from. A Student Resources DVD is packaged with each new copy of the text and contains the popular Engineering Equation Solver (EES) software. McGraw-Hill's new Connect is available to students and instructors. Connect is a powerful, web-based assignment management system that makes creating and grading assignments easy for instructors and learning convenient for students.

Evaluation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments &amp; Other</td>
<td>10%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>Term-Test 1</td>
<td>25%</td>
</tr>
<tr>
<td>Term-Test 2</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30%</td>
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</tbody>
</table>

(Other: attendance, possible on-line assignments, etc)

(May 8th, 1:45 to 4:15 pm)
Course Format and Policy:

Class meetings will include lectures, and examinations. Grades will be based on exams, quizzes, homework, and participation.

- **Assignments:** due on Thursdays at the start of class. Multiple problems will be assigned. However, one to two problems may only be submitted. It is important the student looks at all problems in proper preparation for the exams. Late submission will result in 10% penalty for every day the assignment is submitted late. HW cannot be submitted after the graded work has been returned to the class. The neater and more coherent the work, the better. See page 4 for homework format.

- **Quizzes:** Closed book/closed notes. Concept, vocabulary, brief workout, and problem set up. Some may require calculators, some may not. Quiz grades between each exam will be factored into the respective exam grade in a positive way.

- **Exams:**
  - Closed book and notes; you will be provided with the needed equations for the exam.
  - Combination of concept questions (fill in blank, TF, multiple choice) and workout problems.
  - Only **non-programmable** calculators are allowed.
  - The **final exam** is comprehensive.
  - Make up exams will only be allowed with a valid (university approved) excuse.

- **Attendance** is expected for all classes and recitation sessions. Attendance will be taken periodically too. Quizzes will be given throughout the semester. If you miss a class, you will be responsible for keeping up with the course materials and submitting the HW on time. It is the student’s responsibility to arrange when make-up work (particularly quizzes and exams) will be done providing a reasonable explanation for missing said work.

- **Any act of honor code violation will be reported according to University practices.**

Academic Integrity/Plagiarism:
University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, and complicity or plagiarism. In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in Grade F.

It is encouraged that students do their assignments individually. However, working in groups is encouraged as to help each other. **Submitted work must be the students own work,** unless specified otherwise.

Dropping a Class
Events can sometimes occur that make dropping a course necessary or wise. Please consult with me, or your advisor, before you decide to drop to be sure it is the best thing to do. Dropping a course can result in long term consequences in regards to your degree plan. Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation **WILL NOT** automatically result in your being dropped from the class. **Friday, April 11** is the last day to drop a class with an automatic grade of “W.”

Safety
The safety of students, faculty, staff and visitors to the ET laboratories is a major issue. You must follow safety procedures and use personal protective equipment as required. Skate boards and other large cumbersome equipment needs to be kept in the front of the room. All walkways must be kept clear.
Food and Drinks and other
Eating/drinking is not permitted in the class. In addition, no dipping in the class is allowed.

Classroom/professional and ethical behavior
Students are expected to behave in an ethical and professional manner in all class and lab activities. If you feel uncertain about a particular activity, please speak to me BEFORE problems arise. Ethical behavior is a requirement for passing this course.
Part of this is use of electronic equipment. The class is not the place for texting, surfing the net, playing games and so forth. Use of the devices for referencing course materials is allowed to.
Also, no recording of the lectures is allowed without express written consent of the instructor.

Grade Appeals
A student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is on the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details on the process, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, consult Texas A&M University-Corpus Christi University Procedure 13.02.99.C2.01 Student Grade Appeal Procedures (http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage (http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school or the College of Science and Engineering Dean’s Office.

Disabilities Accommodations
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call or visit Disability Services at (361) 825-5816 in Driftwood 101.
If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

Schedule (Tentative)

<table>
<thead>
<tr>
<th>Week</th>
<th>Days/Date</th>
<th>Topic</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>Jan 23</td>
<td>Intro &amp; Chapt 1</td>
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<tr>
<td>2</td>
<td>Jan 28 &amp; 30</td>
<td>Chapt 1 &amp; Chapt 2</td>
<td>HW, Quiz</td>
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<tr>
<td>3</td>
<td>Feb 4 &amp; 6</td>
<td>Chapt 2 &amp; Chapt 3</td>
<td>HW, Quiz</td>
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<tr>
<td>4</td>
<td>Feb 11 &amp; 13</td>
<td>Chapt 3</td>
<td>HW, Quiz</td>
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<tr>
<td>5</td>
<td>Feb 18 &amp; 20</td>
<td>Review and Exam 1</td>
<td>HW, Exam</td>
</tr>
<tr>
<td>6</td>
<td>Feb 25 &amp; 27</td>
<td>Chapt 4</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>7</td>
<td>Mar 4 &amp; 6</td>
<td>Chapt 4 &amp; Chapt 5</td>
<td>HW, Quiz</td>
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<tr>
<td>8</td>
<td>Mar 18 &amp; 20</td>
<td>Chapt 5 &amp; Chapt 6</td>
<td>HW, Quiz</td>
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<tr>
<td>9</td>
<td>Mar 25 &amp; 27</td>
<td>Chapt 6 &amp; Chapt 7 (part 1)</td>
<td>HW, Quiz</td>
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<tr>
<td>10</td>
<td>Apr 1 &amp; 3</td>
<td>Chapt 7 (P1) Rev &amp; Exam 2</td>
<td>HW, Exam</td>
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<tr>
<td>11</td>
<td>Apr 8 &amp; 10</td>
<td>Chapt 7 part 2</td>
<td>HW, Quiz</td>
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<td>12</td>
<td>Apr 15 &amp; 17</td>
<td>Chapt 9</td>
<td>HW, Quiz</td>
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<tr>
<td></td>
<td>Date</td>
<td>Assignment</td>
<td>Notes</td>
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<tr>
<td>13</td>
<td>Apr 22 &amp; 24</td>
<td>Chapt 10 &amp; Chap 11</td>
<td>HW, Quiz</td>
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<tr>
<td>14</td>
<td>Apr 29 &amp; May 1</td>
<td>Chapt 11</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>15</td>
<td>May 6</td>
<td>Review</td>
<td></td>
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</tbody>
</table>

Final Exam: May 08, 1:45 to 4:15 pm (3:30 class, TD)
Homework Format and Procedure:

Taking the time to include information when working out a problem will help strengthen your knowledge of working out problems. Briefly jotting down a few notes is not a good practice in terms of long term recollection. Documenting where you get information, what you are doing with the information, why a particular step is required, and how you are progressing in a problem is an excellent professional skill to develop.

The following is required for all submitted work:

- Prepare formal solutions on 8-1/2” x 11” ’engineering problem' paper, or white letter paper.
- Work submitted on paper torn out of a spiral notebook will not be accepted.
- Each homework assignment must have a cover page containing pertinent details, such as: name, course & section, HW assignment number (or equivalent), and due date.
- All pages should be stapled together.
- All work should be presented on one side of the paper only.
- If a problem takes more than half a page, then begin each new problem on a new sheet. If there is more than one problem per sheet, then each problem must be separated by a double line.
- Problems must be organized in the same order as assigned, unless specified otherwise.
- Your name, course, section number, and due date must appear at the top of each page.
- The current page number as well as the total number of pages in the assignment must appear in the upper right corner of each page.
- The format for each problem solution should generally consist of:

Problem Info: Summarize the problems statement and include all information that is known about the problem. A bullet list is acceptable. Include sketches or diagrams as appropriate. Original diagram of problem statement should be included too.

Required/Task/Objective: State what has been asked to be determined in complete sentences. Bullet lists work well here too.

Figures: Almost every problem in this course will require detailed diagrams to support your solution! Draw all figures clearly and neatly, use a straight-edge if needed. Show an appropriate and consistent set of units, number each figure, and when appropriate, refer to a figure by its number in the solution. Draw figures such that they are of reasonable size, i.e. no smaller than a 2.5” x 2.5” in area. Also, it is ok and encouraged to draw a figure more than once if needed. Figures are a good place to help define variables and their relation to the problem. Many problems require a reference system too.

Solution: Present your solution in a logical and methodical manner. What are the key equations/relationships that are to be used? What are the assumptions to the problem? Clearly indicate answers by including the variable designation, the numerical value (with units!), and by 'boxing' the answer. Also include any summarizing comments, observations, or conclusions in sentence form as may be appropriate.

Graphs or plots that are required for problems must have properly labeled axis, titles, and legends (if more than one plot on graph).

See an example on the following page
A piston-cylinder device initially contains 0.07 m³ of nitrogen gas at 130 kPa and 120°C. The nitrogen is now expanded polytropically to a state of 100 kPa and 100°C. Determine the boundary work done during this process.

**Conditions:** What is specifically defined in regards to the problem

**Assumptions:** What will be inferred so that a particular relation can be utilized.

\[P_1 = 130 \text{ kPa} = 130(10^3) \text{ Pa} \]
\[T_1 = 120 \degree \text{C} = 373 \degree \text{K} \]

**Final State:**
\[P_2 = 100 \text{ kPa} = 10^5 \text{ Pa} \]
\[T_2 = 100 \degree \text{C} = 373 \degree \text{K} \]
\[V_2 = ? \]

**Task:** \( W_b = ? \)

**Given Data, Remarks:**

**Assumptions:** N₂-70·0·6% gas behaves as an ideal gas

**Boundary Work for Polytropic Process:**
\[ W_b = \frac{P_2 V_2 - P_1 V_1}{1 - n} \tag{2} \]

**For ideal gases, polytropic relation as**

\[ P V^n = \text{constant} \tag{6} \]

And,
\[ P V = m R \] \( \Rightarrow \) \( \frac{P V}{T} = m R \tag{6} \)

**Relating** \( V_2 \) **and** \( n \)

From (6),
\[ \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \]
\[ V_2 = \left( \frac{P_2}{P_1} \right) \left( \frac{T_1}{T_2} \right) V_1 \]
\[ V_2 = \left( \frac{130(10^3)}{100(10^5)} \right) \left( \frac{373}{373} \right)(0.07) \Rightarrow V_2 = 0.08637 \text{ m}^3 \]

From (6),
\[ P_1 V_1^n = P_2 V_2^n \]
\[ \left( \frac{V_2}{V_1} \right)^n = \frac{P_2}{P_1} \]
\[ n = \frac{\ln \left( \frac{P_2}{P_1} \right)}{\ln \left( \frac{V_2}{V_1} \right)} \]
\[ n = 1.248 \]

\[ W_b = \frac{130(10^3)(0.08637) - (130)(10^3)(0.07)}{1 - 1.248} \Rightarrow W_b = 1867 \text{ J} \]

or \( W_b = 1.8745 \text{ kJ} \)