TEXAS A&M UNIVERSITY – CORPUS CHRISTI
MEEN-4360: Thermal System Design
Spring 2015

I. COURSE INFORMATION
COURSE PREREQUISITE: MEEN 3345
Meeting Times & Place: Lecture TR 9:30-10:45 p.m., EN-214

II. PROFESSOR INFORMATION
Instructor: Andrew Conkey PhD
Office: EN 210 Phone: 825-2559
Email: andrew.conkey@tamucc.edu
Office Hours: TBD, by appointment too via email (use your islander email account)

III. TEXTBOOK

Required

Recommended (Books that you used for Thermodynamics, Heat transfer, and Fluids)


Instructor’s Notes (Will be posted on BlackBoard)

IV. COURSE DESCRIPTION (as per 2014-2015 catalog)
Analysis, management and cost, optimal design, and computer simulation of thermal systems and components; Applications in fluid flow and heat transfer, pumps, turbines and heat exchangers. Selected course topics are assigned as projects. Prerequisite: MEEN 3345 - Heat Transfer

Apply principles of thermodynamics, fluid mechanics and heat transfer in design of thermal systems. Topics include

(i) Exergy analysis
(ii) Power and refrigeration systems
(iii) Mixtures
(iv) Psychrometrics and HVAC
(v) Reaction thermodynamics
(vi) Heat exchanger calculation
(vii) Case study: chosen from power generation, HVAC, petrochemical and process industries, avionics or propulsion systems thermal managements, etc. Service learning is encouraged.
V. STUDENT OUTCOMES

1. Students will demonstrate the ability to apply first law and second law analyses to thermal systems at the component level.
2. Students will demonstrate the ability to perform psychrometrics and HVAC calculation.
3. Students will demonstrate the ability to perform combustion calculation.
4. Students will demonstrate the ability to perform heat exchanger calculation.
5. Students will apply knowledge gained to a case study subject to multiple constraints, including economic evaluation and life-cycle assessment.

VI. ASSESSMENT AND GRADE ASSIGNMENT

The methods of evaluation and the criteria for grade assignments are:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>8%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>12%</td>
</tr>
<tr>
<td>Exam 1</td>
<td>20%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>20%</td>
</tr>
<tr>
<td>Proposal &amp; Presentation</td>
<td>15%</td>
</tr>
<tr>
<td>Written Reports</td>
<td>25%</td>
</tr>
</tbody>
</table>

Grading Scale: A = 100-85; B = 75-84; C = 65-74; D = 55-64; F = below 54

VII. CLASS POLICIES

Attendance: Attendance will be taken every lecture. All students are expected to attend all classes and arrive on time. Professional behavior is expected; no phone calls or texting messages in class. Homework assignments will be posted on MEEN-4360 BlackBoard page. Late homework will only be accepted for an acceptable cause, for example, death in family, car accident, hospitalized, doctor appointments, etc. Late homework must be made up within one week of the absence. Homework will be accepted if it is delivered to me by 5:00 p.m. on the due date. Late assignments be accepted the discretion of the instructor. See page 5 for format

Quizzes will be concept based as well as short work out or problem set up. Administered at the beginning of the Tuesday lecture and cover material (lecture, example problems, and homework) from the previous week. Quizzes taken between each exam will be factored into the respective exam grade in a positive manner.

Exams:
- May be open or 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, short answer) and workout problems.
- Only calculators (recommend ones that can interpolate) are allowed. No smart devices, tablets, computers, etc are allowed.
- Make up exams will only be allowed with a valid (university approved) excuse.
Writing Assignments and Oral Presentations: Students will write one team proposal, three team progress reports, and one team report on a Case Study. The students will give an oral report (team) of the Case Study. These will be assessed based on grammar, formatting, and technical content.

Design Component: Students will have problems (homework, quiz, and/or exam) involving the design of thermal and fluid systems. Students will apply the knowledge gained to a team design project that includes engineering analysis, economic evaluation and life cycle assessments.

Do NOT write your SSN or the student ID on the homework submitted. Pages are to be numbered and stapled at the upper-left corner.

VIII. Tentative COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Days/Date</th>
<th>Topic</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 22</td>
<td>Introduction &amp; Systems Overview</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Jan 27 &amp; 29</td>
<td>Systems &amp; design and Review 1st and 2nd Law of</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermodynamics</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Feb 3 &amp; 5</td>
<td>Exergy Analysis</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>4</td>
<td>Feb 10 &amp; 12</td>
<td>Exergy Analysis</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>5</td>
<td>Feb 17 &amp; 19</td>
<td>Cycles: Rankine</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>6</td>
<td>Feb 24 &amp; 26</td>
<td>Cycles: Brayton</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>7</td>
<td>Mar 3 &amp; 5</td>
<td>Review Exam 1</td>
<td>HW, Exam 1</td>
</tr>
<tr>
<td>8</td>
<td>Mar 10 &amp; 12</td>
<td>Cycles: Internal Combustion/Project</td>
<td>HW, Exam 1</td>
</tr>
<tr>
<td>9</td>
<td>Mar 24 &amp; 26</td>
<td>Cycles: Refrigeration &amp; Heat Pumps</td>
<td>HW, Quiz, Proposal</td>
</tr>
<tr>
<td>10</td>
<td>Mar 31 &amp; Apr 2</td>
<td>Gas Mixtures/psychrometrics &amp; HVAC</td>
<td>HW, Exam</td>
</tr>
<tr>
<td>11</td>
<td>Apr 7 &amp; 9</td>
<td>HVAC/Evaporative Cooling</td>
<td>HW, Prog Rep 1</td>
</tr>
<tr>
<td>12</td>
<td>Apr 14 &amp; 16</td>
<td>Combustion Thermodynamics</td>
<td>HW, Quiz</td>
</tr>
<tr>
<td>13</td>
<td>Apr 21 &amp; 23</td>
<td>Fluid Flow aspects &amp; Heat exchangers</td>
<td>HW, Quiz, Prog Rep 2</td>
</tr>
<tr>
<td>14</td>
<td>Apr 28 &amp; 30</td>
<td>Heat Exchangers/review/</td>
<td>HW, Exam 2, Prog Rep 3</td>
</tr>
<tr>
<td>15</td>
<td>May 5</td>
<td>Open topics/Case study</td>
<td>Final Report Due</td>
</tr>
<tr>
<td>FE</td>
<td>May 7</td>
<td>Project Presentation</td>
<td></td>
</tr>
</tbody>
</table>

Important Dates: April 10th – last day to drop. May 4th Last day to withdrawn

IX. INSTRUCTIONAL METHOD

Lectures, group discussions, home assignments, spreadsheet based calculations, textbook software for computer-aided solutions. The student is expected to have read the chapter before coming to the class.

X. E-mail:

Use only your TAMUCC Islander account on emails. Also, can use the BlackBoard message service too. Must enter MEEN-4360 in the email’s subject field, then follow with topic (HW, Quiz, Missed Class, Project, etc.)

XI. FOOD AND DRINKS AND OTHER

No eating in laboratory/computer areas. No dipping, vaping, or other tobacco use in class (refer to the university tobacco use policy).
XII. SUPPORT SERVICES FOR STUDENTS WITH DISABILITY
Texas A&M University-Corpus Christi complies with the Americans with Disabilities Act in making reasonable accommodations for qualified students with disabilities. If you suspect that you may have a disability (physical impairment, learning disability, psychiatric disability, etc.), please contact the Services for Students with Disabilities Office, located in Driftwood 101 (DW-101), at 825-5816. If you need disability accommodations in this class, please see me as soon as possible.

ACADEMIC HONESTY
The engineering and engineering technology professions are based on truth, honesty, integrity, and professionalism. Scholastic dishonesty will not be tolerated. See the University Catalog sections on Academic Integrity and Academic Honesty. Cell phones and electronic communication devices are NOT permitted in the exam.

XIII. 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.
Homework Guidelines:

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, or for preparation for the exams. 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. In addition, the detailed workout will be necessary for the course project.

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
Note: Can insert problem statement as shown, or you can paraphrase it, or make it into a bullet list.

6-56 Refrigerant-134a enters the condenser of a residential heat pump at 800 kPa and 35°C at a rate of 0.018 kg/s and leaves at 800 kPa as a saturated liquid. If the compressor consumes 1.2 kW of power, determine (a) the COP of the heat pump and (b) the rate of heat absorption from the outside air.

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

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

![Diagram of refrigeration cycle]

**Governing Relations**

- **Condenser:**
  \[ Q_c = m_c (h_{1} - h_{2}) \]

- **Compressor:**
  \[ \text{COP}_{\text{comp}} = \frac{m_{\text{in}} (h_{1} - h_{2})}{W_{\text{in}}} \]

- **Evaporator:**
  \[ Q_{\text{in}} = \frac{m_{\text{in}} (h_{1} - h_{2})}{W_{\text{in}}} \]

**Problem Solution:**

- **State 1:**
  - \( h_{1} = 3.31 \) kJ/kg
  - \( h_{2} = 271.2 \) kJ/kg
  - \( h_{3} = 276.4 \) kJ/kg

- **Conditions:**
  - \( P_1 = 800 \text{ kPa} \)
  - \( T_1 = 35^\circ \text{C} \)
  - \( m = 0.018 \text{ kg/s} \)

- **Assumptions:**
  - \( \eta_{\text{comp}} = 0.9 \)
  - \( T_{\text{in}} = 3.31 \text{ kJ/kg} \)
  - \( T_{\text{out}} = 271.2 \text{ kJ/kg} \)

- **COP:**
  \[ \text{COP} = \frac{m_{\text{in}} (h_{1} - h_{2})}{W_{\text{in}}} = 0.018 \]

- **Heat Absorption:**
  \[ Q_{\text{in}} = 0.018 (271.2 - 95.1) = 3.16 \text{ kW} \]

- **COP of Heat Pump:**
  \[ \text{COP}_{\text{hp}} = \frac{Q_{\text{in}}}{1.2} = 2.67 \]

- **Heat Absorption from Outside Air:**
  \[ Q_{\text{out}} = 3.16 - 1.2 = 1.96 \text{ kW} \]