Instructor: Dr. Alan H. George
Office: Roberts 119
Office Hours: to be announced
Format: 3 credit lecture
Prerequisites: ME/EMEC 321 Thermodynamics II and ME/EMEC 326 Heat Transfer; or as listed in the current MSU Catalog. Current regulations require that a grade of "C-" or better must be earned in all prerequisite courses.
Lecture Periods and Room(s): T Th 2:05-2:55 p.m., Reid 101; W 3:10-4:00 p.m., Reid 101
Textbook: Borgnakke, C., and Sonntag, R. E., Fundamentals of Thermodynamics, Seventh Edition, Wiley, 2009. Students who are progressing in the normal course sequence for mechanical engineering majors should already have this textbook. The Eight Edition of the textbook is not a good substitute since the material is arranged in different chapters, equation numbers are different, etc.

Grading Basis:

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<tr>
<td>midterm examinations</td>
<td>96% (total)</td>
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<tr>
<td>final examination</td>
<td>4%</td>
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<tr>
<td>total</td>
<td>100%</td>
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In recent semesters, grade intervals have been near the traditional values of 60% minimum for D-, 70% minimum for C-, 80% minimum for B-, and 90% minimum for A. Students who consistently arrive late at class meetings or disrupt normal course activities will have their grades reduced. Chronic complaining about the course content, instructional methods, or course personnel will also be cause for grade reduction.

No make-up examinations will be given. One midterm examination missed due to serious cause, e.g., a job interview, participation as an athlete in university sanctioned athletic events, illness, or funeral attendance, will be considered to have the student’s average score of other examinations scheduled including the Final Examination. The Final Examination must be taken at the time indicated in the published Final Examination Schedule (see the MSU Web Page). In addition to the current material, all examinations include material from Thermodynamics I (ME/EMEC 320) and Thermodynamics II (ME/EMEC 321). All examinations are in-class, require the textbook, require a calculator, and may require the use of materials provided during lectures.

Additional policies related to grades and prerequisites can be found in the current Undergraduate Catalog http://www.montana.edu/wwwcat/programs/mie.html#ME.

Course Objectives and General Information:

During Spring Semester 2010, the course was revised to a lecture format. The course is still under development and additional revisions in the course content will occur this semester.
**Outcome 1:** The objective of the course is to extend previous training in thermodynamics and fluid mechanics. Subjects will include the modern thermodynamics topics of availability and exergy, the thermodynamics of reacting systems including chemical equilibrium calculations and related First Law and Second law analyses, and introduction to the mechanics and thermodynamics of compressible fluid flow.

**Outcome 2:** Several numerical formulations which require a computerized solution, e.g., Mathcad, will be developed. Therefore, proficiency with Mathcad or some alternative code, e.g., Matlab, is expected and required. An introduction to commercial computer codes, e.g., GASEQ, for computing the equilibrium composition and properties of ideal gas mixtures will be provided.

After about the second week of classes, help sessions (supplemental instruction sessions) under the direction of an ME senior or ME graduate student will be conducted at a time and place to be announced. It is expected that the help sessions will respond to questions regarding the homework solutions, review topics in the current course, and review topics in the prerequisite courses. The help session before each examination will be mainly to review some of the examination topics. Attendance at these help sessions is optional and not part of the course grading basis.

Students with learning disabilities or other special academic needs should contact the instructor if they require any special provisions for examinations or other assignments. In addition, regulations regarding academic integrity and other student conduct may be found on the MSU Webpage, e.g., [http://www2.montana.edu/policy/student_conduct/cg600.html](http://www2.montana.edu/policy/student_conduct/cg600.html).

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EMEC 425  
Fall 2013  
Dr. George

Updates to the list of assignments will be made as needed in class and on the course webpage.

Homework is no longer submitted or graded but solutions or partial solutions will be posted on the course D2L webpage. While no strict due dates apply, the homework problems for a particular week should be completed by the end of the week following the assignment, i.e., the first assignment (problems 10.17, 10.18, 10.20, 10.21) for the week of 26 August should be completed by the end of the following week of 2 September.

### Reading and Homework Assignment Schedule

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<th>Week of</th>
<th>Reading/Problems</th>
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| 26 Aug   | Review Ch. 10 in the Thermodynamics book, section 10.1, reversible work, lost work, irreversibility  
Problems: 10.17, 10.18, 10.20, 10.21 |
| 02 Sept  | Ch. 10 in the Thermodynamics book, sections 10.2-10.4, availability, Second Law efficiency, and exergy (Holiday Monday)  
Problems: 10.24, 10.25, 10.26, 10.30 |
Reading and Homework Assignment Schedule (cont.)

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| 09 Sept  | Ch. 10 in the Thermodynamics book, sections 10.2-10.4, availability, Second Law efficiency, and exergy  
Problems: 10.36, 10.39, 10.45, 10.54, 10.61, 10.63 |
| 16 Sept  | Review Ch. 15 in the thermodynamics book, combustion, balancing reaction equations, First Law and Second Law analyses, and adiabatic flame temperature. Introduction to additional sources of thermodynamic property data, e.g., NIST-JANAF Thermochemical Tables (1998).  
Problems: 10.78, 10.85, 10.101, 15.20, 15.21, 15.68, 15.73 (assume only H2O as product) |
| 23 Sept  | Review Ch. 15 cont., Ch. 16 in the thermodynamics book, chemical equilibrium; basic theory and equations  
Problems: 16.22, 16.24, 16.30  
EXAMINATION 1 Reversible Work, Irreversibility, Thermodynamic Availability, the Exergy Balance Equation, and Related Issues |
| 30 Sept  | Ch. 16 Chemical Equilibrium cont.; single reactions  
Review of Mathcad nonlinear equation solver(s) for single equations  
Problems: 16.34, 16.44, 16.49, 16.62 |
| 07 Oct   | Ch. 16 Chemical Equilibrium cont.; simultaneous reactions  
Review of Mathcad nonlinear equation solver(s) for simultaneous equations  
Problems: 16.74, 16.74 again but with O and H also in products |
| 14 Oct   | Ch. 16 Chemical Equilibrium cont.; simultaneous reactions cont.;  
GASEQ Computer Code for Chemical Equilibrium of Ideal Gas Mixtures  
Problems: handout |
| 21 Oct   | Ch. 17 in the thermodynamics book, compressible flow  
Problems: 17.14, 17.16, 17.21, 17.32, 17.36  
EXAMINATION 2 Chemical Equilibrium and Related Issues |
| 28 Oct   | Ch. 17 in the thermodynamics book, compressible flow  
Problems: 17.50 (assume isentropic flow), 17.65, 17.66, 17.68 |
| 04 Nov   | Ch. 17 in the thermodynamics book, compressible flow  
Problems: 17.40 (assume ideal gas), 17.41, 17.43 |
| 11 Nov   | Ch. 17 in the thermodynamics book, compressible flow (Holiday Monday)  
Problems: 17.44, 17.45, 17.46, 17.49, 17.64, 17.69 |
### Reading and Homework Assignment Schedule (cont.)

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| 18 Nov  | Rocket Engine Thrust and Specific Impulse, Notes  
(last day to withdraw from the course is 19 November)  
**EXAMINATION 3 Compressible Flow and Related Issues**  
Problems: Handout |
| 25 Nov  | Rocket Engine Thrust and Specific Impulse, continued, Notes  
Oblique Shock Waves, Notes and Handouts  
(Holidays Wednesday, Thursday, and Friday)  
Problems: Handout |
| 02 Dec  | Prandtl-Meyer Expansion Waves, Notes and Handouts  
Summary comments concerning compressible flow, Notes  
Problems: Handout |
| 09 Dec  | **FINAL EXAMINATION Comprehensive**, Monday, 9 December 2013,  
12:00-01:50 p.m., Reid 101 |