NORTH CAROLINA STATE UNIVERSITY DEPARTMENT OF MECHANICAL & AEROSPACE ENINEERING

Summer 2015

MAE-302, Thermodynamics II

1.1. Instructor's name, office address, telephone number, e-mail address, regularly scheduled class meeting times, and office hours for out-of-class consultation.

Sec: 001
Location: 2236 EBIII
Days: MTWTF
Time: 08:30-10:00

Instructor: Dr. James Kribs
Office: 2212, Engineering Building III
E-Mail Address: jdkribs@ncsu.edu
Office Telephone: 919-513-0315
Office Hours: T Th 10:15-11:30

1.2. Course prerequisites or restrictive statements.

Prerequisites: CSC 112 and a grade of C or better in MAE 301

1.3. Designation of course as a General Education Requirement (GER). N/A

1.4. Student learning outcomes for the course.

Course Motivation: This course places emphasis on the analysis and design of power and refrigeration cycles and the application of the basic principles to engineering design problems with systems involving mixtures of ideal gases, psychrometrics, nonideal gases, chemical reactions, combustion, chemical equilibrium, and one-dimensional compressible flow.

Course Objectives: The students will be asked to demonstrate their knowledge of the material covered in MAE 302 through their mastery of the following course objectives. Through the study of MAE 302 the student will be able to:

- Sketch figures of systems and control volumes;
- Sketch process diagrams for the processes occurring within systems and control volumes;
- Develop the governing equations for conservation of mass, conservation of energy, and process relations for processes occurring in systems and control volumes;
- Determine the required thermodynamic properties from tables for real substances (water and refrigerant 134a), tables for ideal gases, and equations of state for ideal gases. substitute these property values with units into the governing equations and simplify;
- Analyze ideal gas power cycles to perform energy balances, determine heat and work transfers, and calculate the cycle efficiency;
- Analyze steam power cycles to perform energy balances, determine heat and work transfers, and calculate the cycle efficiency;
- Analyze vapor compression refrigeration cycles to perform energy balances, determine heat and work transfers, and calculate the cycle coefficient of performance;

- Calculate properties of ideal gas mixtures;
- Determine the properties of dry air-water vapor mixtures, plot processes on a psychrometric chart, and analyze process involving dry air-water vapor mixtures to perform energy and mass balances for the processes;
- Determine balanced chemical reaction equations and analyze typical combustion processes to perform energy balances to determine the heat transfer released or estimate the maximum possible product gas temperature during combustion;
- Calculate stagnation properties of high-speed flows and apply these properties to isentropic flow though nozzles and to the process occurring across a normal shock wave.

1.5. All required Textbook(s), title(s), date(s), price(s), Calculators, price(s)

Y. A. Çengel and M. A. Boles, Thermodynamics: an Engineering Approach (Packet including Property Table Booklet), 7th Ed, The McGraw Hill Companies, New York.

Only models of calculators approved by the instructor are permitted to be used in the classroom during tests and the final exam. *No other models of calculators or variations of the models listed below are permitted during tests and the final exam.* The following are the only calculators that will be permitted in the classroom during tests and the final exam and are the only ones allowed on the Fundamentals of Engineering Exam. Prices for these calculators range from $9.95 to $20.00.

Hewlett Packard – HP 33S
Casio – FX 115MS or FX 115MSPlus
Texas Instruments – TI 30X IIS
Texas Instruments – TI 36X SOLAR

1.6. Course organization and scope. List of topics and approximate time allocated to each major topic.

Topics covered: (number of classes): Based on 3 classes per week for 14 week semesters, classes meet 3 days per week for 50 minute lectures (or 2 days per week for 75 minute lectures):

1. Gas power cycles (6)
2. Steam power cycles (8)
3. Refrigeration cycles (3)
4. Ideal gas mixtures and psychrometrics (6)
5. Combustion processes (6)
6. Chemical equilibrium (3)
7. Ideal compressible flow (6)
8. Review and tests (4)

1.7. Projected schedule of reading assignments.

	Day	Topic	Sections
May	18	Basic Considerations, Carnot cycle, Air standard cycle	9.1-9.4
		Otto Cycle	9.5
	19	Diesel Cycle	9.6
	20	Stirling, Ericsson, Brayton Cycles	9.7-9.8
	21	Brayton Cycle with Regeneration, Intercooling, Reheating	9.9-9.10
		Ideal Jet-Propulsion Cycles, Second-Law Analysis	9.11-9.12
	22	Carnot and Rankine Vapor Cycles	10.1-10.3
		Parameters Affecting Efficiency, Reheat Cycle	10.4-10.5
	25	***Holiday***	
	26	Regenerative Rankine Cycle	10.6
	27	**Test 1**	
	28	Second-Law Analysis of Vapor Power Cycles	10.7
		Cogeneration	10.8
	29	Combined Gas-Vapor Power Cycles	10.9
June	1	Refrigerators & Heat Pumps, Reversed Carnot Cycle	11.1-11.2
		Ideal Refrigeration cycle	11.3
	2	Actual Vapor-Compression Refrigeration Cycle	11.4
		Advanced Refrigeration Topics	11.5-11.9
	3	Composition of Gas Mixtures	13.1
		P-v-T Behavior of Gas Mixtures	13.2
		Properties of Gas Mixtures	13.3
	4	Properties of Gas-Vapor Mixtures	14.1-14.3
		Adiabatic Saturation and Wet-Bulb Temperatures	14.4
		Psychrometric Chart, Air Cond. Processes	14.5-14.7
	5	**Test 2**	
	8	Fuels and Combustion	15.1
	9	Theoretical and Actual Combustion Processes	15.2
	10	Enthalpy of Formation and Enthalpy of Combustion	15.3
		First-Law Analysis of Reacting Systems	15.4
	11	Adiabatic Flame Temperature	15.5
		Entropy Change of Reacting Systems	15.6
	12	Second-Law Analysis of Reacting Systems	15.7
	15	Stagnation Properties, Speed of sound and Mach number	17.1-17.2
	16	One Dimensional Isentropic Flow	17.3
	17	**Test 3**	
	18	Isentropic Flow through Nozzles	17.4
		Shock Waves and Expansion Waves	17.5
	19	Review	
June	**22**	**Final Exam 8:00-11:00 AM**	