Department of Mechanical Engineering
Mechanical Engineering Department

ME 312– Thermodynamics II

(Required)

Catalog Description: **ME 312 (3 0 3)**

A continuation of ME 311 including studies of irreversibility and combustion. Thermodynamic principles are applied to the analysis of power generation, refrigeration, and air-conditioning systems. Introduction to solar energy thermal processes, nuclear power plants, and direct energy conversion.

Prerequisites: ME 311 - Thermodynamics I
Reason for prerequisites: *Thermodynamics II* is the second part of a two-semester course on Thermodynamics.

Textbook(s)/Materials Required:
Yunus A. Cengel and Michael A. Boles. THERMODYNAMICS: An Engineering Approach , 4th Edition, McGraw-Hill, NY, 2002, ISBN 0-07-238332-1

Course Supervisor: Dr. Boris Khusid

Pre-requisite by topic:
1. Ideal gases
2. Thermodynamic properties of pure substances
3. First law analysis of open systems, steady and transient processes
4. The second law of thermodynamics and entropy
5. Entropy change during processes
6. Energy, work potential

Course Objectives[1]:
1. To develop the student's ability to apply the principles of thermodynamics to the optimal design of the basic energy conversion systems: power generation, refrigeration, air-conditioning, and combustion. (A, B, C, D)
2. To develop the student's ability to use thermodynamic relations and the property tables and charts for the analysis of energy conversion systems in the course of their operation. (A, B, C, D)
3. To develop the student's ability to apply the first and the second laws of thermodynamics to the optimization of the basic energy conversion systems. (A, B, C, D)
4. To provide the students with some knowledge and analysis skills associated with the principles of operation and applications of the main energy conversion systems. (A, B, C, D, E)
5. To provide the students with some knowledge and analysis skills associated with the principles and techniques of the design of energy conversion systems. (A, B, C, D, E)
6. To develop the student's ability to communicate effectively the knowledge of thermodynamics and energy conversion systems. (A, B, C, D, E)

Topics[2]:

1. **Gas Power Cycles**

Concepts of gas power cycles and their applications: Otto cycle, Diesel cycle, Brayton cycle, Jet-propulsion cycles. (9 hrs)

2. **Vapor Power Cycles**

Concepts of vapor power cycles and their applications: Rankine cycle for vapor power plants, Reheat Rankine cycle, Regenerative Rankine cycle (9 hrs)

3. **Refrigeration Cycles**

Concepts of refrigeration cycles and their applications: Refrigerators and heat pumps, Vapor-compression refrigeration cycle. Selection of the right refrigerant. Heat pump systems. Gas refrigeration cycles (6 hrs)

4. **Gas Mixtures**

Composition of a gas mixture. P-v-T behavior of gas mixtures. Thermodynamic properties of gas mixtures (3 hrs)

5. **Gas-vapor Mixtures and Air-conditioning**

Dry and atmospheric air. Specific and relative humidity of air. Dew-point and wet-bulb temperatures. The psychrometric chart. Air-conditioning processes. Wet cooling towers. (6 hrs)

6. **Chemical Reactions**

Fuels and combustion and their applications. Theoretical and actual combustion processes. Enthalpy of formation and enthalpy of combustion. Steady-flow and closed reacting systems. First law analysis of reacting systems. Adiabatic flame temperature. Second-law analysis of reacting systems (6 hrs)

7. **Thermodynamics of High-speed Gas Flow**

High-speed gas flows and their applications. Stagnation properties. Velocity of sound and Mach number. One-dimensional isentropic flow. Isentropic flow through nozzles. (3 hrs)

8. **Review** (3 hrs)

Evaluation Method:

1. Quizzes
2. Exam
3. Homework

Schedule: Lecture Recitation: 3 hours, per week

Professional Component: Engineering Science

Program Objectives Addressed: A, B, C, D, E

Course Outcomes[3] **:**

Objective 1

Students will demonstrate an ability to apply thermodynamic principles to the design, analysis, and optimization of the basic energy conversion systems: power generation, refrigeration, air-conditioning, and combustion. (1,2,3) (a,c,e,g,h,j,k)

Objective 2

Students will demonstrate an ability to use thermodynamic relations and the physical property tables and charts for the analysis of gas and vapor power mixtures, phase transformations, chemical reactions, and combustions processes. (1,2,3) (a,e,g,h,j,k)

Objective 3

Students will demonstrate an ability to apply the first and the second laws of thermodynamics to the analysis and optimization of the power generation, refrigeration, air-conditioning, combustion, and gas flow processes. (1,2,3) (a,c,e,g,h,k)

Objective 4

Students will demonstrate an ability to determine engineering design quantities and estimate their effects on the basic performance characteristics of the energy conversion systems. (1,2,3) (a,c,e,g,h,j,k)

Objective 5

Students will demonstrate an ability to design the basic energy conversion systems, select working fluids, and estimate the effects of pressure, temperature, and flow rate on the system efficiency. (1,2,3) (a,c,e,g,h,j,k)

Objective 6

Students will demonstrate an ability to communicate effectively the knowledge of thermodynamic principles, energy balance equations, and the use of the physical property tables and charts for the analysis of the energy conversion systems. (1,2,3) (g,h,j,k)

Prepared by: Boris Khusid **Date:** September 22, 2006

---

[1] Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering
Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

[2] Topic numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

[3] Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.