Kingsborough Community College
The City University of New York
Department of Physical Sciences

EGR 2300 - Introduction to Engineering Thermodynamics

Syllabus

EGR 2300 – INTRODUCTION TO ENGINEERING THERMODYNAMICS (3 crs. 4 hrs.)
First course in engineering thermodynamics, topics include: Zeroth Law and absolute temperature; work, heat, First Law and applications; Second Law, Carnot theorems, entropy, thermodynamic state variables and functions, reversibility, irreversibility, and availability functions; Ideal gas mixtures, mixtures of vapors and gas, humidity calculations, and Third Law. Required for Engineering Science Majors. Prerequisites: CHM 1200, PHY 1400 Co-requisite: CS1200

Section: SECTION NUMBER
Time: LECTURE AND LABORATORY SCHEDULE FOR SECTION
Room: ROOM (S) FOR SECTION
Instructor: INSTRUCTOR FOR SECTION
Email: EMAIL ADDRESS FOR INSTRUCTOR FOR SECTION
Office Hours: OFFICE HOURS FOR INSTRUCTOR FOR SECTION

Source materials: The textbook is *Thermodynamics, by Yunus Cengal, published by McGraw Hill Higher Education-Latest Edition*. Scientific calculator – You may not use a cell phone as a calculator!

Course Learning Outcomes:

- Identify the unique vocabulary associated with thermodynamics through the precise definition of basic concepts to form a sound foundation for the development of the scientific principles to follow and to prevent possible misunderstandings.
- Understand the English and the metric SI unit systems that will be used throughout the text.
- Explain the basic concepts of thermodynamics such as system, state, state postulate, equilibrium, process, cycle, energy, and various forms of energy.
- Review concepts of temperature, temperature scales, pressure, and absolute and gage pressure.
- Introduce an intuitive systematic problem-solving technique that can be used as a model in solving engineering problems.
- Introduce the concept of a pure substance.
- Discuss the physics of phase-change processes.
- Illustrate the P-v, T-v, and P-T property diagrams and P-v-T surfaces of pure substances.
- Demonstrate the procedures for determining thermodynamic properties of pure substances from tables of property data.
- Describe the hypothetical substance "ideal gas" and the ideal-gas equation of state.
- Apply the ideal-gas equation of state in the solution of typical problems.
- Introduce the compressibility factor, which accounts for the deviation of real gases from ideal-gas behavior, and to illustrate its use.
- Define the specific heat at constant volume and the specific heat at constant pressure.
- Relate the specific heats to the calculation of the changes in internal energy and enthalpy of ideal gases.
- Describe the incompressible substance such as solids and liquids and how to determine the changes in internal energy and enthalpy for these substances.
- Identify the types of energy that may be transferred to or from a thermodynamic system.
- Define the meaning of heat transfer and work.
- Determine that energy in the form of heat or work may cross the boundaries of a closed (fixed mass) system.
- Examine the various forms of work, with particular emphasis on the moving boundary work or PdV work commonly encountered in reciprocating devices such as automotive engines and compressors.
- Determine that a fluid flowing across a control surface of a control volume carries energy across the control surface in addition to any energy transfer across the control surface that may be in the form of heat and/or work.

- Identify the energy carried by a fluid stream crossing a control surface as the sum of internal energy, flow work, kinetic energy and potential energy of the fluid and to relate the combination of the internal energy and the flow work to the property enthalpy.
- Discuss the conservation of mass principle.
- Apply the conservation of mass principle to various systems including steady- and unsteady-flow control volumes.
- Identify the first law of thermodynamics as simply a statement of the conservation of energy principle, and it asserts that total energy is a thermodynamic property.
- Develop the general energy balance, which is expressed as Ein - Eout = DEsystem is developed in a step-by-step manner using an intuitive approach.
- Solve energy balance problems for closed (fixed mass) systems that involve heat and work interactions for general pure substances, ideal gases, and incompressible substances.
- Solve energy balance problems for steady flow systems and common steady-flow devices such as nozzles, compressors, turbines, throttling valves, mixers, and heat exchangers.
- Apply the energy balance to general unsteady-flow processes with particular emphasis on the uniform-flow process, which is the model process for commonly encountered charging and discharging processes.
- Introduce the second law of thermodynamics, which asserts that processes occur in a certain direction and that energy has quality as well as quantity.
- Identify valid processes as those that satisfy both the first and second laws of thermodynamics.
- Introduce the concepts of thermal energy reservoirs, reversible and irreversible processes, heat engines, refrigerators, and heat pumps.
- Describe the Kelvin-Planck and Clausius statements of the second law of thermodynamics.
- Apply the second law of thermodynamics to cycles and cyclic devices.
- Apply the second law to determine the absolute thermodynamic temperature scale.
- Describe the Carnot cycle.
- Examine the Carnot principles, idealized Carnot heat engines, refrigerators, and heat pumps.
- Discuss the energy conservation associated with the use of household refrigerators.
- Apply the second law to processes.
- Define a new property called entropy as it applies to commonly encountered engineering processes.
- Discuss the Clausius inequality, which forms the basis for the definition of entropy.
- Explain the increase of entropy principle.
- Calculate the entropy changes that take place during processes for pure substances, incompressible substances, and ideal gases.
- Examine a special class of idealized processes, called isentropic processes and develop the property relations for these processes.
- Derive the reversible steady-flow work relations.
- Develop the isentropic, or adiabatic, efficiencies of various steady-flow engineering devices and apply the definitions to turbines, compressors, and nozzles.
- Introduce and apply the entropy balance to various systems.
- Evaluate the performance of gas power cycles for which the working fluid remains a gas throughout the entire cycle.
- Review the operation of reciprocating engines.
- Solve problems based on the Otto, Diesel, Stirling, and Ericsson cycles.
- Solve problems based on the Brayton cycle, the Brayton cycle with regeneration, and the Brayton cycle with intercooling, reheating, and regeneration.
- Analyze vapor power cycles in which the working fluid is alternately vaporized and condensed.
- Analyze the reheat and regenerative vapor power cycles.
- Analyze the ideal vapor-compression refrigeration cycle.
- Analyze the actual vapor-compression cycle.

Topical Outline : (Approximate and subject to change upon notification)

Meetings	*Topic*
1-5	***Basic Concepts of Thermodynamics:*** Dimensions and Units**,** Properties of a System**,** Processes and Cycles**,** Forms of Energy**,** Temperature and the Zeroth Law of Thermodynamics**,** Pressure**,** The Manometer & Barometer and the Atmospheric Pressure
6-10	***Properties of Pure Substances:*** Phase-Change Processes of Pure Substances**,** Property Diagrams for Phase-Change Processes**,** Property Tables**,** The Ideal-Gas Equation of State**,** Compressibility Factor**,** Other Equations of State**,** Internal Energy, Enthalpy and Specific Heats Of Ideal Gases**,** Internal Energy & Enthalpy and Specific Heats Of Solids and Liquids *Exam 1 Basic Concepts of Thermodynamics –Meeting 8*
11-15	***Energy Transfer by Heat, Work, and Mass:*** Heat Transfer**,** Energy Transfer by Work**,** Mechanical Forms of Work**,** Nonmechanical Forms of Work**,** Conservation of Mass Principle & Flow Work and the Energy of a Flowing Fluid *Exam 2 Properties of Pure Substances –Meeting 13*
16-20	***The First Law of Thermodynamics:*** The First Law of Thermodynamics**,** Energy Balance for Closed Systems and Steady-Flow Systems & Steady-Flow Engineering Devices *Exam 3 Energy Transfer by Heat, Work, and Mass –Meeting 18*
21-25	***The Second Law of Thermodynamics:*** Thermal Energy Reservoirs**,** Heat Engines**,** Energy Conversion Efficiencies**,** Refrigerators and Heat Pumps**,** Reversible and Irreversible Processes**,** The Carnot Cycle & Carnot Heat Engine, Carnot Refrigerator and Heat Pump *Exam 4 The First Law of Thermodynamics –Meeting 23*
26-30	***Entropy:*** The Increase of Entropy Principle**,** Entropy Change of Pure Substances**,** Isentropic Processes**,** Property Diagrams Involving Entropy**,** The *T ds* Relations**,** Entropy Change of Liquids and Solids**,** The Entropy Change of Ideal Gases & Isentropic Efficiencies of Steady-Flow Devices *Exam 5 The Second Law of Thermodynamics –Meeting 28*
31-35	***Gas, Vapor and Combines Power Cycles:*** Basic Considerations in the Analysis of Power Cycles, Otto, Diesel, Brayton, Stirling and Ericsson Cycles, The Carnot Vapor Cycle & Rankine Cycle *Exam 6 Entropy –Meeting 33*
36	***Review***
37	***Final Exam*** **–** *Comprehensive* --- Date/Time/Room as per Official College Final Exam Schedule

Grading Evaluation: Grades are calculated from a weighted average of exams.

6 exams	75% (12.5% each)	A 88% - 100%
Final Exam	25%	B 75% - 87%
		C 63% - 74%
		D 50% - 62%
		F 0% - 49%

Missed Exam Policy

If you miss an opportunity to demonstrate your knowledge of the subject matter by missing a duly scheduled exam, the grading scheme does not apply. Your grade will be determined at the discretion of the instructor. By missing a duly scheduled exam you accept and recognize that the instructor must determine your grade within the context of determining the grade of students who did not miss a duly scheduled exam. Instructor Exam Make-up Policy: SUGGESTED: NO MAKE-UP EXAMS. FINAL EXAM WEIGHTED WITH PENALTY (0-100%) FOR MISSED WORK

Conduct: Students are required to follow *The Student Code of Conduct* as stated in the *Student Handbook*.

Accessibility: Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. Your instructor will make the accommodations you need once you provide documentation from the Access-Ability office (D205). Please contact AAS for assistance.

Suggested Problems

Chapter 1: Textbook Edition Dependent	Chapter 5: Textbook Edition Dependent
Chapter 2: Textbook Edition Dependent	Chapter 6: Textbook Edition Dependent
Chapter 3: Textbook Edition Dependent	Chapter 7: Textbook Edition Dependent
Chapter 4: Textbook Edition Dependent	Chapter 8: Textbook Edition Dependent