COURSE CODE:	ME-204		
COURSE NAME:	Thermodynamics		
CREDIT HOURS:	Theory = 03	Practical = 01	Total = 04
CONTACT HOURS:	Theory = 48	Practical = 48	Total = 96
PREREQUISITE:	None		
MODE OF TEACHING:	Instruction: 3 hours of Lecture per week (70%) Lab Demonstration: 3 hours of Lab work per week (30%)		

COURSE DESCRIPTION:

This course will cover the fundamental concepts involved in thermodynamics, properties and phases of pure substances, conservation of energy balance around engineering devices, processes and cycles for reversible and irreversible thermodynamic systems, and thermodynamics applications in environmental engineering.

COURSE OBJECTIVES:

The primary objectives of this course are:

- to enable students to learn basic knowledge of thermodynamics; and
- to study temperature-dependent processes in environmental engineering.

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Teamwork:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE LEARNING OUTCOMES (CLOs):

Upon successful completion of the course, the student will be able to:

Sr#	CLOs	Domain	Taxonomy Level	PLOs
1	**EXPLAIN** the basic concepts of thermodynamics.	Cognitive	2	1
2	**SOLVE** the problems for energy recovery potential of wastes.	Cognitive	3	2
3	**IMPLEMENT** the concepts of thermodynamics in the laboratory.	Psychomotor	2	1
4	**Maintain** ethical conduct in lab and adhere to lab safety procedures while contributing effectively towards individual and/ or group goals.	Affective	5	9

PRACTICAL APPLICATIONS:

This course will develop a deeper understanding of the basic principles involved in the working of various engineering devices such as combustors in incinerators, boilers and turbines in waste-to-energy plants, Rankine cycle in thermal power plants, etc. It will also help the students to optimize the combustion process and select the best air-to-fuel ratio

to control the exhaust gasses emissions and to calculate the energy potential of various waste types. In addition, problem-solving skills will be further developed when the various techniques are thought out and applied to solve the problem statements in a clear and orderly way.

TOPICS COVERED:

Theory:

Week	Topics	Reading Assignment / Homework	CLO#
1	Basics of thermodynamics; open and closed systems; properties of system; processes and cycles	Chapter 1	1
2	Zeroth law of thermodynamics; thermodynamic equilibrium; pressure; temperature	Chapter 1 Quiz 1	1
3	Energy; forms of energy; mechanisms of energy transfer; mechanical forms of work	Chapter 2	1
4	First law of thermodynamics; energy balance; energy change; general energy analysis; energy conversion efficiencies	Chapter 2 Assignment 1 Quiz 2	1, 2
5	Pure substance: properties, phases, and phase-change processes	Chapter 3	1
6	Property diagrams for phase change process; property tables; ideal and non-ideal gas behavior; ideal-gas equation of state; compressibility factor	Chapter 3 Assignment 2 Quiz 3	1, 2
7	Moving boundary work; energy balance for closed systems	Chapter 4	1, 2
8	Specific heat; internal energy; enthalpy in closed systems	Chapter 4 Quiz 4	1
9	Conservation of mass; flow work and energy of flowing fluid; energy analysis of steady-flow systems	Chapter 5	1, 2
10	Steady flow energy devices	Chapter 5 Quiz 5	1, 2
11	Second law of thermodynamics; Kelvin-Planck and Clausius statements; thermal energy reservoirs; heat engines; thermal efficiency	Chapter 6	1
12	Performance of refrigerators; heat pumps; and air-conditioners; coefficient of performance; perpetual-motion machines; reversible and irreversible processes; Carnot cycle and principles	Chapter 6 Assignment 3 Quiz 6	2
13	Entropy; increase of entropy principle; entropy change of substances; isentropic processes	Chapter 7 Assignment 4	1
14-15	Gas power cycles; vapor and combined power cycles; refrigeration cycles	Chapter 8	1
16	Chemical reactions; conventional and alternate fuels; combustion; ignition temperature; theoretical and actual combustion processes; complete and incomplete combustion; enthalpy of formation and enthalpy of combustion; air-fuel ratio; heating value (energy content) of fuels and wastes	Chapter 9	1, 2

Practical:

Sr#	Experiment	CLO#
1	Thermodynamics Lab: Boyle's Law	3
2	Thermodynamics Lab: Expansion of a Perfect Gas	3
3	Thermodynamics Lab: Temperature Measurement Bench	3
4	Thermodynamics Lab: Marcet Boiler	3
5	Thermodynamics Lab: Mechanical Heat Pump	3
6	Thermodynamics Lab: Steam Power Plant	3
7	Thermodynamics Lab: Axial Flow gas Turbine	3
8	Automotive Research Centre (ARC): Internal combustion Engines Lab-1	3
9	Automotive Research Centre (ARC): Internal combustion Engines Lab-2	3

TEXT AND MATERIAL:

Textbook(s):

1. Cengel & Boles. 2015. Thermodynamics-An Engineering Approach. 8th Ed. McGraw-Hill, New York.

Reference Materials:

1. Applied Thermodynamics for Engineering Technologists by A. McConkey.
2. Thermodynamics Applied to Heat Engines by E. H. Lewitt.
3. Basic Engineering Thermodynamics by Rayner Joel

ASSESMENT SYSTEM:

Theoretical/Instruction	**100%**
Assignments	10%
Quizzes	15%
Mid Semester Exam	25%
End Semester Exam	50%

Practical Work	**1000%**
Lab Attendance	10%
Lab Report	30%
Lab Quiz	30%
Lab Rubrics	30%