National University of Sciences & Technology (NUST)
School of Electrical Engineering and Computer Science (SEECS)
Department of Electrical Engineering

Thermodynamics

Course Code:	ME102	**Semester:**	Fall 2021
Credit Hours:	2+0	**Pre-requisites:**	Engineering Mechanics / Equivalent
Instructor:	Dr. Ahmed Rasheed	**E-mail:**	ahmed.rasheed@seecs.edu.pk
Office:	Innovation Hub – Office 2	**Telephone:**	N/A
Students Batch:	BEE-12 (CD)	**Discipline/Year:**	Electrical Engineering/Second
Lecture/Lab Days:	Tuesday and Wednesday	**Consulting Hours:**	**Thurs:** 1400-1500 Hrs or via email
Lab Engr:	N/A	**E-mail:**	N/A
Knowledge Group:	Mechanics	**Updates on LMS:**	on required basis

Course Description:

The aim of the course is to give basic concepts of thermodynamics. The students will learn to evaluate basic thermodynamic variables involved in different thermodynamic processes of closed and open systems. An energy balance of various thermodynamic cycles will be taught. This course is a pre-requisite of Thermodynamics-II and provides foundation for power plants, gas dynamics and energy divisions of the mechanical engineering.

Course Objectives:

The course is intended for engineering students and covers the fundamentals of applied thermodynamics, the relations between fluid properties and quantities of work and heat which accompany changes of state. The course is designed as a bridge between the sciences of thermodynamics and fluid dynamics to understand better the processes of heat and mass transfer and their applications to modern industry. It should also help students to appreciate the elegance and power, as well as the limitations of the science he is using.

Course Learning Outcomes (CLO)

Upon successful completion of this course the students will be able to demonstrate the following:-		**BT LEVEL**	**PLO**
CLO_1	Able to illustrate the basic concepts of thermodynamics and its application in various industrial components.	**C2**	**1**
CLO_2	Able to identify, heat and/or work interactions between system and surroundings and formulate thermodynamic properties of open and closed system by using laws of thermodynamics.	**C3**	**2**
CLO_3	Compute and demonstrate thermodynamic processes on appropriate thermodynamic diagrams, such as a temperature-entropy or pressure-volume diagram.	**C3**	**2**
CLO_4	Able to analyze the feasibility of systems and their impact on environment using the laws of thermodynamics under the aspects of power, energy and entropy of closed systems and control volumes.	**C4**	**7**
* BT=Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A=Affective domain			

Mapping of CLOs TO Program Learning Outcomes

PLOs/ CLOs	CLO-1	CLO-2	CLO-3	CLO-4
PLO1 (Engineering Knowledge)	√			
PLO2 (Problem Analysis)		√	√	
PLO3 (Design/Development of Solutions)				
PLO4 (Investigation)				
PLO5 (Modern tool usage)				
PLO6 (The Engineer and Society)				
PLO7 (Environment and Sustainability)				√
PLO8 (Ethics)				
PLO9 (Individual and Team Work)				
PLO10 (Communication)				
PLO11 (Project Management)				
PLO:12 (Lifelong Learning)				

Lecture Breakdown

Lec. Hrs. / Lec. Nos.	Course Contents / Topics	Chapters	CLOs
2/1-2	**Introduction** • Class rules and regulations • Overview of objective based education system and its significance • Distribution of OBE based course outline document and its discussion • Why, What, How, Where questions about Electronics field and course? • Career prospects of Electronics course and field **Introduction** • Introduction to thermodynamics • System and its types • Macroscopic view and microscopic view • Properties of systems, extensive and intensive properties, specific properties, equilibrium and its types	TBA/TBU	CLO-01
2/3-4	• Temperature and zeroth law of thermodynamics • Thermodynamic concept of energy • Energy and work transfer • First law of thermodynamics for closed and open system • Problem solving	TBA/TBU	CLO-01
2/5-6	• Properties of pure substance • Liquid vapor phase change process • T-v and P-v diagram	TBA/TBU	CLO-02

	• Derivation of properties like internal energy, specific volume, enthalpy and entropy for vapor		
2/7-8	• Use of steam table for calculating thermodynamic properties of steam • Problem Solving	TBA/TBU	CLO-02
2/9-10	• Ideal gas equation of state • Specific heat capacity and its types • General relations for ideal gas • Problem solving	TBA/TBU	CLO-02
2/11-12	• Reversible and irreversible processes • Causes of irreversibilities • Reversible non-flow processes • Constant volume process and constant pressure process • Problem solving	TBA/TBU	CLO-03
2/13-14	• Constant temperature or isothermal process • Reversible adiabatic flow process • Problem solving	TBA/TBU	CLO-03
2/15-16	• Polytropic process • Reversible flow processes • Problem solving	TBA/TBU	CLO-03
2/17-18	• Irreversible processes • Heat transfer through a finite temperature difference • Unresisted or free expansion • Throttling • Problem solving	TBA/TBU	CLO-03
2/19-20	• Second law of thermodynamics and concept of entropy • Entropy change in constant pressure and constant volume process • Problem solving	TBA/TBU	CLO-03
2/21-22	• Entropy change in isothermal process • Entropy change in reversible adiabatic process • Problem solving	TBA/TBU	CLO-03
2/23-24	• Rankine cycle: The ideal cycle for vapor power cycles • Energy analysis of ideal Rankine cycle • Problem solving	TBA/TBU	CLO-04
2/25-26	• Enhancements to increase the efficiency of Rankine cycle • Lowering the condenser pressure • Superheating the steam to high temperature • Problem solving	TBA/TBU	CLO-04

Mapping of CLOs to Assessment Modules and Weight ages (in accordance with NUST statutes)

To be filled in at the end of the course

CLOs\PLOs	CLO-1	CLO-2	CLO-3	CLO-4
Assignments:				
Mid-Semester Exam:				
End Semester Exam:				
Total: 100				

Books:

Text Book:
1. Y. A. Cengel, M. A. Boles, "Thermodynamics: An Engineering Approach", 8th or 9th Edition (SI Units), McGraw-Hill Education, (2016).

Reference Books:
1. M. J. Moran, H. N. Shapiro, D. D. Boettner, "Fundamentals of Engineering Thermodynamics", 7th Edition, J. Wiley & Son. (2011)
2. R. E. Sonntag and C. Borgnakke, "Fundamentals of Thermodynamics", 8th Edition, Wiley, (2012).

Main Content and Lecture Breakdown:

Introduction & Basic Concepts:
Thermodynamics, system and boundary, specific volume, Pressure and Temperature, Methods to solve thermodynamics problems

Energy & First law of thermodynamics:
Forms of mechanical energy, Understanding Work and Energy, Energy balance of system, Energy analysis of cycles, Energy storage

Thermodynamic Properties Evaluation:
Phase and pure substance, p-v-T relation, Evaluating pressure, specific volume, temperature, enthalpy and internal energy, Introduction of specific heats, compressibility, evaluating properties using ideal gas law

Control Volume Analysis using Energy:
Conservation of mass for control volume, forms and applications of mass rate balance, Conservation of energy for control volume, Applications to Nozzles, diffusers, turbines, compressors and pumps, Throttling devices

Second Law of Thermodynamics:
Introduction and statements of second law, Irreversible and reversible process, Interpreting Kelvin-Plank statement, Aspects of Power, refrigeration and heat pump cycles in terms of second law, Carnot cycle, Clausius inequality

Using Entropy:
Entropy and its evaluation, T-ds equation, Entropy change in an irreversible process, Entropy rate balance of closed systems and control volumes, Directionality of processes, Isentropic processes and efficiencies of nuzzles, compressors, pumps

Grading Policy:	
Assignments Policy	The assignments are a mandatory component of the overall assessment. The purpose of assignments is to keep the students up-to-date with the lecture material and test basic understanding of the course concepts. Late assignments will not be considered/accepted/graded. All assignments will count towards the total. The students are advised to the assignments themselves. Copying is highly discouraged and will be dealt with strict action. Each assignment will consist of questions that target specific topics from the most recent as well as previous week lectures.
Other Matters:	
Academic Honesty and Plagiarism	Plagiarism is the unacknowledged use of other's work, including the copying of assignments and laboratory results from the other students. Plagiarism is considered a serious offence by the university and severe penalties apply. Therefore, all the students must display originality of efforts and avoid plagiarism in any form.
Classroom Etiquettes	It is the collective responsibility of all the students to make the class environment conducive for learning. To create and maintain a friendly atmosphere, the following standards of class room behavior will be observed: - 1. Students will be punctual for the class. The teacher considers late comers disrespectful of those who manage to be on time. 2. If a student decides to attend the class, he or she will not disrupt class by leaving before the lecture has ended. 3. All the cell phones must be switched OFF prior to entering the class room.