Module (Advanced Thermodynamics) Catalogue 2023-2024

College/ Institute	**Erbil Technical Engineering College**	
Department	**Mechanical and Energy Engineering Techniques**	
Module Name	**Advanced Thermodynamics**	
Module Code	**ADT104**	
Degree	**Technical diploma** ☐ **Bachler** ☐ **High Diploma** ☐ **Master** ■ **PhD** ☐	
Semester	**1**	
Qualification	**PhD**	
Scientific Title	**Lecturer**	
Credits	**7**	
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐	
Weekly hours	**3 hr.**	
Weekly hours (Theory)	**(3)hr. Class**	**(36) hr. Workload**
Weekly hours (Practical)		
Number of Weeks	**12**	
Lecturer (Theory)	**Dr. Hindren Ali Saber**	
E-Mail & Mobile NO.	**hindren.saber@epu.edu.iq , 07507430728**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites	**https://academicstaff.epu.edu.iq/faculty/hindren.saber**	

Course Book

Course Description	Thermodynamics is the science that deals with heat and work and those properties of substance that bear a relation to heat and work. Thermodynamics is the study of the patterns of energy change. Most of this course will be concerned with understanding the patterns of energy change. This course covers thermodynamics concepts at a graduate level. It covers applications of the first and second laws of thermodynamics to the analysis of engineering systems, availability analysis, equations of state, thermodynamic property relations, mixtures, chemical equilibrium, and combustion.
Course objectives	• To present thermodynamics concepts taught in undergraduate thermodynamics courses in more depth. • To teach more advanced, graduate level, thermodynamics concepts. • To demonstrate how different thermodynamics concepts can be used to analyze various engineering systems. • To teach basics of research and engineering. **Student Learning Objectives** • To demonstrate a deep understanding of various thermodynamics concepts and principles. • To master the use of thermodynamics principles in analyzing engineering systems. • To learn how to use advanced tools such as spreadsheets and equation solvers when thermodynamics principles are used to analyze complex engineering systems. • To learn elements of research in thermodynamics and energy analysis.
Student's obligation	• Class attendance and arriving on time are encouraged. • Participation in class discussions is encouraged. • There will be several quizzes during the academic year, not necessarily announced. The quiz contains the materials covered in previous lectures. • There are 90-minute midterm exams and a 180 -minute final exam. All tests are in class, closed book, and closed notes. • Any quiz or test missed without a supported documented and excused absence will represent a zero.

<table>
<tr><td>Required Learning Materials</td><td colspan="5">• Data show, white board and PowerPoint are used throughout the lecture.
• Publish all lecture notes in college website before the lecture day.</td></tr>
<tr><td rowspan="11">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Assignment</td><td>Homework</td><td></td><td></td><td></td></tr>
<tr><td>Class Activity</td><td></td><td></td><td></td></tr>
<tr><td>Report</td><td></td><td></td><td></td></tr>
<tr><td>Seminar</td><td></td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Lab.</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td></td><td></td><td></td></tr>
<tr><td>Specific learning outcome:</td><td colspan="5">15. Student learning outcome:
Ch. 1: INTRODUCTION AND BASIC CONCEPTS (Thermodynamics and Energy, Dimensions and Units, Systems And Control Volumes, Properties of a System, Density and Specific Gravity, Processes and</td></tr>
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	Cycles, Temperature and The Zeroth Law of Thermodynamics, Pressure ….etc). **Ch.2: ENERGY** (Forms of Energy, Energy Transfer by Heat, Energy Transfer by Work, Mechanical Forms of Work, The First Law of Thermodynamics …Etc). **Ch.3: PROPERTIES OF PURE SUBSTANCES** (Pure Substance, Phases of Pure Substances, Saturation Temperature and Saturation Pressure, Property Diagrams for Phase-Change Process, Property Tables, Dryness Fraction, Superheated Vapor. IDEAL-GAS Equation of State). **Ch.4: First Law of Thermodynamics (CLOSED SYSTEM).** (Moving Boundary Work, Energy Analysis of Closed System, The Cycle, Internal Energy, Enthalpy and Specific Heats Of Ideal Gases, …etc) **Ch.5: First Law of Thermodynamics (CONTROL VOLUMES)** (Mass and Volume Flowrate, Energy Analysis of a steady Flow System, , STEADY-FLOW Devices, Nozzles and Diffusers, Turbines and Compressors , Throttling Valves , Mixing Chambers , Heat Exchangers , …etc). **Ch.6: THE SECOND LAW OF THERMODYNAMICS** (The Heat-Engine (HE), Thermal Efficiency, Kelvin–Planck Statement, Refrigerators and HEAT PUMPS (HP), Coefficient of Performance COP, The CARNOT CYCLE…etc.). **Ch.7: MEASURE OF DISORDER (ENTROPY)** (Internally Reversible Isothermal Heat Transfer Processes, Entropy Change of Pure Substances, Isentropic Process, Entropy Change of Incompressible substances (Liquids and Solids), The ENTROPY CHANGE of Ideal Gases, Isentropic Efficiency of Turbines, Isentropic Efficiencies of Compressors and Pumps….etc). **Ch.8: EXERGY: A MEASURE OF WORK POTENTIAL** (Concept of exergy & irreversibility, Exergy analyses of open and closed system Unavailable work (or energy) concept, available and non-available energy , exergy balance for a closed system, exergy balance for an open system …etc.). **Ch.9: VAPOUR AND GAS POWER CYCLES** (Review of Thermodynamics, Rankine Cycle, Performance of Rankine Cycle, Binary Vapour Cycle, Steam Generators, Fire Tube Boilers, Water Tube Boilers, Boiler Mountings and Accessories, High Pressure Boilers-LaMont and Benson Boilers, Steam Turbines, Compounding of Steam Turbines, Impulse Steam Turbines, Impulse Steam Turbine Performance , Gas Turbine Cycles, Gas Turbine Cycle- Performance Evaluation, Gas Turbine Cycle- Effect of Operating Variables, Problem Solving, Centrifugal Compressors, Centrifugal Compressor Characteristics, Axial Flow Compressors, Axial Flow Compressor Characteristics, Combustion Systems. …etc.). **Ch.10: REFRIGERATION AND AIR CONDITIONING** (ideal refrigeration cycles, actual cycles, refrigerants, air conditioning properties, psychometry, cooling towers. …etc.).

	Ch.11: THERMODYNAMIC PROPERTY RELATIONS (Maxwell relations; Relations involving enthalpy, internal energy and entropy; Mayer relation, Clausius-Clapeyron equation, Joule-Thompson experiment….etc.). **Ch.12: GAS MIXTURES AND CHEMICAL REACTIONS** (Multi-component and multi-phase systems, Equations of states and properties of ideal and real gas mixtures, Change in entropy in mixing. Combustion and thermochemistry, Reactant and product mixtures, Adiabatic flame temperature, Chemical equilibrium, Equilibrium products of combustion. ….etc.).
Course References:	• Cengel, Yunus A. and Michael A. Boles, Thermodynamics: An Engineering Approach, Seventh Edition, New York, McGraw-Hill: 2011. • R.K. RAJPUT, ENGINEERING THERMODYNAMICS: M.E. (Heat Power Engg.); C.E. (India) Principal (Formerly) Punjab College of Information Technology PATIALA, Punjab. • Kalyan Annamalai and Ishwar K. Puri, Advanced Thermodynamics Engineering, CRC Series in Computational Mechanics and Applied Analysis. • Adrian Bejan J. A. Jones, Advanced Engineering Thermodynamics, John Wiley & Sons, 4th Edition: 2016. • Michael J. Moran & Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, 6th Edition, 2010. • Mehrzad Tabatabaian and R. K. Rajput, Advanced Thermodynamics, Fundamentals, Mathematics, Applications, Mercury Learning and Information, 2017. • Claus Borgnakke and Richard E. Sonntag, University of Michigan, John Wiley & Sons, 8th Edition: 2012.

Course topics (Theory)	Week	Learning Outcome
Introduction and basic concepts. Energy, Energy transfer, and General energy analysis. Properties of pure substances.	1	
First law of thermodynamics	2	
Second law of thermodynamics	3	
Measure of disorder (entropy)	4	
Exergy: A Measure of work potential	5	
Gas power cycles and Combined power cycles	6	
Refrigeration cycles and air conditioning	7	

Thermodynamics property relations	8	
Gas mixtures	9	
Chemical reactions	10	
Chemical and phase equilibrium	11	
High speed gas flow	12	
Practical Topics	**Week**	**Learning Outcome**

Questions Example Design

Q 1/ Distinguish between

a) Intensive property and extensive property
b) Heat and work

Q2/a- Entropy of 1 kg of steam at 5 bar is 5 kJ/kg.k, calculate the heat spent measured from water at 0℃ to this final condition.

b- The Carnot cycle operates between temperature of 4.4℃ and 32.2℃. investigate the effectiveness (respectively in terms of COP and **η**) of this cycle when its purpose is

- To provide refrigeration
- To deliver power

Q3/ True or False type of exams

Weight of a system is an intensive property whereas specific weight and specific gravity are extensive property. TRUE/ FALSE√

Q4/Multiple choise

Which of the following is an intensive property of thermodynamic system?

(a) Volume (b) Temperature

(c) Mass (d) Energy

Extra notes:

No extra notes

External Evaluator

While reviewing the course catalogue and its contains, it appears that it offers the necessary areas for students to comprehend the advanced thermodynamics and their analyses.

Prof. Dr. Ahmad Mohammed Adham