MODULE DESCRIPTION FORM

<table>
<tr><th colspan="6">Module Information</th></tr>
<tr><td>Module Title</td><td colspan="3">Thermodynamics</td><td colspan="2">Module Delivery</td></tr>
<tr><td>Module Type</td><td colspan="3">Core</td><td colspan="2" rowspan="4">☒ Theory
☐ Lecture
☒ Lab
☒ Tutorial
☐ Practical
☐ Seminar</td></tr>
<tr><td>Module Code</td><td colspan="3">PM 201</td></tr>
<tr><td>ECTS Credits</td><td colspan="3">8</td></tr>
<tr><td>SWL (hr/sem)</td><td colspan="3">200</td></tr>
<tr><td>Module Level</td><td>2</td><td colspan="2">Semester of Deliver</td><td colspan="2">3</td></tr>
<tr><td>Administering Department</td><td>PM</td><td>College</td><td colspan="3">TEMO</td></tr>
<tr><td>Module Leader</td><td>Anwar Ahmed Yousif</td><td>e-mail</td><td colspan="3">nawarayousif@ntu.edu.iq</td></tr>
<tr><td>Module Leader’s Acad. Title</td><td>lecturer</td><td colspan="2">Module Leader’s Qualification</td><td colspan="2">MSc. Mechanical Engineering</td></tr>
<tr><td>Module Tutor</td><td>Name (if available)</td><td>e-mail</td><td colspan="3">E-mail</td></tr>
<tr><td>Peer Reviewer Name</td><td>Name</td><td>e-mail</td><td colspan="3">E-mail</td></tr>
<tr><td>Scientific Committee Approval Date</td><td>01/06/2023</td><td colspan="2">Version Number</td><td colspan="2">1.0</td></tr>
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<tr><th colspan="4">Relation with other Modules</th></tr>
<tr><td>Prerequisite module</td><td>None</td><td>Semester</td><td></td></tr>
<tr><td>Co-requisites module</td><td>None</td><td>Semester</td><td></td></tr>
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Module Aims, Learning Outcomes and Indicative Contents	
Module Objectives	1. The aim is to enhance problem-solving abilities and gain a comprehensive comprehension of thermodynamics theory by utilizing various methodologies. 2. The objective is to grasp the principles of thermodynamics and the laws governing energy. 3. The course primarily focuses on the fundamental notions of heat, work, and energy. 4. This subject serves as a foundational component for understanding different systems employed in thermodynamics. 5. The goal is to comprehend the principles that govern the conversion of energy between different thermodynamic systems. 6. Students will be introduced to the field of thermodynamics through the examination of thermal systems and their interactions with the surrounding environment in terms of energy.
Module Learning Outcomes	1. Classify and define various terms related to thermodynamics. 2. Provide a concise explanation of the concept of thermodynamics. 3. Analyze the involvement and behavior of atoms in chemical reactions. 4. Explain the concepts of thermal energy, work, and energy in the context of thermodynamics. 5. Define Boyle's law and understand its significance in thermodynamics. 6. Differentiate between open and closed systems and comprehend their respective applications. 7. Explore the processes of heat transfer between thermal systems. 8. Evaluate the characteristics and functions of measuring devices used in laboratory settings. 9. Elaborate on Joule's law and its implications in thermodynamics. 10. Identify and apply relevant mathematical relationships for problem-solving purposes.
Indicative Contents	**Part A** Course Introduction: This initial module provides an introduction to the course, including an overview of the content and objectives. It also introduces the recommended textbooks and outlines the different units that will be covered. [15 hrs] Key Definitions: In this module, we will focus on important definitions related to force, pressure, and system. By understanding these fundamental concepts, students will be better equipped to grasp the subsequent topics. [15 hrs] Pressure and its Types: This module explores the concept of pressure in detail, examining its various types and their respective characteristics and

	applications. Students will spend significant time understanding and analyzing pressure in different contexts.. [10 hrs] Specific Heat at Constant Pressure and Volume: This module covers specific heat and its variations under constant pressure and constant volume conditions. Students will gain an understanding of the significance of specific heat and its practical implications. The module will also address closed system procedures, including those related to constant volume and constant pressure conditions. [15 hrs] Revision problem classes [6 hrs] **Part B** Fundamentals: Temperature: This section covers the measurement of temperature, including units of measurement, conversion between different scales, various measuring methods, and the principles of the Zeroth Law of Thermodynamics. Energy: The concept of energy is defined, and different forms of energy such as potential, kinetic, and thermal energy are explained. Work, capacity, flow work, and pressure diagrams are also discussed. Internal energy and enthalpy are introduced as important thermodynamic properties. [9 hrs] Steam Procedures and Pressure-Volume Chart: This topic focuses on the procedures related to steam and their representation on a pressure-volume chart. Students will learn about the behavior of steam during various processes and how to interpret and analyze such processes graphically. [10 hrs] Types of Pressure Gauges in Refrigeration: This section covers the different types of pressure gauges commonly used in refrigeration systems. Students will become familiar with these gauges, their working principles, and their specific applications in refrigeration processes. [6 hrs] Types of Air Velocity Gauges and Their Uses: This topic explores the various types of air velocity gauges and their respective uses. Students will learn about the different instruments used to measure air velocity and how these measurements are relevant in various contexts, such as HVAC systems or airflow analysis. [6 hrs]

Learning and Teaching Strategies	
Strategies	The primary methodology employed in delivering this module aims to actively involve students in exercises that will enhance their critical thinking skills and promote engagement. This will be achieved through a combination of lectures, interactive tutorials, and the inclusion of various types of simple experiments. These experiments will be designed to captivate students' interest and provide hands-on experience in the subject matter. The overall objective is to encourage active learning, foster critical thinking, and create an engaging learning environment for the students.

Student Workload (SWL)			
Structured SWL (h/sem)	**123**	**Structured SWL (h/w)**	**8**
Unstructured SWL (h/sem)	**77**	**Unstructured SWL (h/w)**	**5**
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**200**		

Module Evaluation					
		Time/Number	**Weight (Marks)**	**Week Due**	**Relevant Learning Outcome**
Formative assessment	**Quizzes**	**4**	**10% (10)**	**3, 5, 8 and 11**	**LO #1, #2, #5, and #8**
	Assignments	**3**	**10% (10)**	**4, 9 and 12**	**LO #3, #4, #6, #9**
	Projects / Lab.	**10**	**20% (20)**	**Continuous**	**All**
	Report				
Summative assessment	**Midterm Exam**	**2hr**	**10% (10)**	**7**	**LO #1 - #7**
	Final Exam	**3hr**	**50% (50)**	**16**	**All**
Total assessment			**100% (100 Marks)**		

Delivery Plan (Weekly Syllabus)	
	Material Covered
Week 1	Introduction to Thermodynamics; Overview, system, surroundings, boundary, properties
Week 2	First Law of Thermodynamics; Energy transfer and work, Heat transfer and thermal energy, Conservation of energy principle
Week 3	Second Law of Thermodynamics; Heat engines and refrigerators, Carnot cycle and efficiency, Entropy and its significance
Week 4	Entropy and its Applications; Calculation of entropy changes, Entropy generation and irreversibility, Entropy balance in thermodynamic processes
Week 5	Properties of Pure Substances; Equations of state, Phase diagrams and phase equilibrium, Ideal gas behavior
Week 6	Vapor and Gas Power Cycles; Rankine cycle, Brayton cycle, Combined cycles
Week 7	Refrigeration and Heat Pump Systems; Vapor compression refrigeration, Absorption refrigeration, Coefficient of Performance (COP)
Week 8	Thermodynamic Property Relations; Maxwell's equations, Departure functions, Compressibility factor
Week 9	Mixtures and Psychometrics; Properties of mixtures, Psychrometric properties and processes, Air conditioning and humidity control
Week 10	Chemical Reactions and Thermodynamics; Enthalpy of reactions, Gibbs free energy and chemical equilibrium, Chemical equilibrium constant
Week 11	Exergy and Second Law Analysis; Exergy analysis and applications, Availability and irreversibility, Second law efficiency
Week 12	Power and Refrigeration Cycles; Gas power cycles (Otto, Diesel, and more), Refrigeration cycles (Cascade, Multi-stage, etc.)
Week 13	Introduction to Heat Transfer; Modes of heat transfer (conduction, convection, radiation), Fourier's law, Newton's law of cooling, Stefan-Boltzmann law
Week 14	Heat Exchangers; Types of heat exchangers, Effectiveness-NTU method, Heat exchanger design and analysis
Week 15	Review and Applications; Review of key concepts and principles, Applications of thermodynamics in various industries, Final exam preparation
Week 16	**Preparatory week before the final Exam**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: Introduction to Laboratory Safety and Equipment
Week 2	Lab 2: Measurement of Temperature and Heat Transfer; Calibration, Determination of heat transfer coefficients, Analysis of heat conduction experiments
Week 3	Lab 3: Measurement of Pressure and Flow; Calibration, Measurement of pressure drops in flow systems, Flow rate measurements using different devices (venturi meter, orifice plate, et
Week 4	Lab 4: Measurement of Thermodynamic Properties; Determination of specific heat capacity of substances, Measurement of enthalpy changes in chemical reactions, Calculation of thermodynamic properties using steam tables or software
Week 5	Lab 5: Performance Analysis of Heat Engines and Refrigeration Systems
Week 6	Lab 6: Experimental Analysis of Energy Conversion Systems
Week 7	Lab 7: Data Analysis and Report Writing

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	1. "Thermodynamics: An Engineering Approach" by Yunus A. Çengel and Michael A. Boles 2. "Fundamentals of Engineering Thermodynamics" by Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey 3. "Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, Hendrick C. Van Ness, Michael M. Abbott, and Mark T. Swihart	No
Recommended Texts	1. "Thermodynamics: An Engineering Approach" by Yunus A. Çengel and Michael A. Boles 2. "Fundamentals of Engineering Thermodynamics" by Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey 3. "Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, Hendrick C. Van Ness, Michael M. Abbott, and Mark T. Swihart	No
Recommended Texts	Heat and mass transfer (SI UNITS) (Er. R. K. RAJPUT) (S. CHAND)	No
Websites	(https://www.khanacademy.org/science/physics/thermodynamics) (https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/) (https://www.engineeringtoolbox.com/thermodynamics-d_28.html)	

Grading Scheme مخطط الدرجات				
Group	**Grade**	**التقدير**	**Marks %**	**Definition**
Success Group (50 - 100)	**A - Excellent**	امتياز	**90 - 100**	**Outstanding Performance**
	B - Very Good	جيد جدا	**80 - 89**	**Above average with some errors**
	C - Good	جيد	**70 - 79**	**Sound work with notable errors**
	D - Satisfactory	متوسط	**60 - 69**	**Fair but with major shortcomings**
	E - Sufficient	مقبول	**50 - 59**	**Work meets minimum criteria**
Fail Group (0 – 49)	**FX – Fail**	راسب (قيد المعالجة)	**(45-49)**	**More work required but credit awarded**
	F – Fail	راسب	**(0-44)**	**Considerable amount of work required**

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above**.**

Code	Course/Module Title	ECTS	Semester
PM 201	Thermodynamics	8	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/sem)**
4	4	123	5
Description			
Thermodynamics is a branch of physics that deals with the study of energy and its transformations in various systems. It focuses on understanding the behavior of heat, work, and energy flow. Thermodynamics encompasses fundamental principles such as the laws of thermodynamics, which describe the relationships between energy, heat, and work. It explores concepts like temperature, pressure, entropy, and equilibrium. Thermodynamic principles find applications in various fields, including engineering, chemistry, and environmental science. By analyzing thermodynamic processes and systems, scientists and engineers can optimize energy utilization, design efficient engines and power plants, and understand the behavior of substances under different conditions.			