PHY3290: THERMODYNAMICS

Effective Term
Semester B 2023/24

Part I Course Overview

Course Title
Thermodynamics

Subject Code
PHY - Physics
Course Number
3290

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
PHY1101 Introductory Classical Mechanics or
PHY1201 General Physics I*

Precursors
MA2158 Linear Algebra and Calculus

Equivalent Courses
Nil

Exclusive Courses
MSE3190 Thermodynamics of MaterialsAP3290 Thermodynamics

Additional Information
* This pre-requisite requirement is waived for Advanced Standing I students (admitted in 2015/16 and thereafter) and Advanced Standing II students.

Part II Course Details

Abstract

To develop a basic understanding in elementary concepts of thermodynamics. To understand the laws of thermodynamics, property relationships and equilibrium of thermodynamics systems.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	State the laws of thermodynamics.			x	
2	Identify thermodynamic cycles and apply the principle to a heat engine.			x	
3	Recognize the thermodynamic property relationships.			x	
4	Describe the equilibrium of a thermodynamic system.			x	
5	Explain basic statistic thermodynamics theory.			x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture/Tutorial	Explain and discuss the key concepts about laws of thermodynamic, thermodynamic relationships, single component phase equilibria and statistical thermodynamics	1, 2, 3, 4, 5	39
2	Laboratory	To demonstrate all the ley concepts learned in the lecture and tutorial sessions by experimentation	1, 2, 3, 4, 5	10

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	1, 2, 3, 4, 5	20	There will be one mid-term test
2	Lab reports	1, 2, 3, 4, 5	10	Students need to complete a number of experiments that demonstrate the principles discussed in lectures/tutorials
3	Assignment	1, 2, 3, 4, 5	10	Take-home or in-classassignments.

Continuous Assessment (%)
40

Examination (%)
60

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained

Assessment Rubrics (AR)

Assessment Task
1. Test

Criterion
Able to solvenumerical problems,and demonstrate theunderstanding ofbasic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
2. Lab reports

Criterion
Ability to explain themethodology andresults fromexperiments

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
3. Assignment

Criterion
Able to solvenumerical problems,and demonstrate theunderstanding ofbasic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
4. Examination

Criterion
Able to solvenumerical problems,and demonstrate theunderstanding ofbasic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Part III Other Information

Keyword Syllabus

- Introduction and the 1st laws of thermodynamics
  Systems and surroundings, energy transfer, internal energy, heat, work, temperature, enthalpy, steady state, heat capacities, thermal expansion, first law of thermodynamics, constant volume process, cyclical process, adiabatic process, free expansion process.
- The 2nd law of thermodynamics and heat engines
  Second law of thermodynamics, heat engine, thermo efficiency, refrigerators, coefficient of performance, reversibility and irreversibility, Carnot engine, entropy, isentropic processes.
- Property relationships
  Thermodynamic relations, Maxwell relations, specific heat, Mayer relation, general relations, Clapeyron equation, Clapeyron-Clausius equation.
- Equilibrium
  Thermodynamic equilibrium, phase equilibrium, phase rule, phase equilibrium for a multi-component system, chemical equilibrium, equilibrium constant for ideal-gas mixtures.
- Applications
  Analyze all processes in a vapor power system, gas power system, refrigeration and heat pump systems and calculate their performance
- Statistical thermodynamics
  Macrostates and microstates, Boltzmann distribution, distinguishability of particles, Maxwell-Boltzmann distribution, indistinguishability of particles, Maxwell speed distribution for gas molecules, Fermi-Dirac distribution, mean free path, diffusion in gases.

Reading List

Compulsory Readings

	Title
1	Lecture slides (will be distributed during the lecture sessions)
2	Tutorial slides (will be distributed during the tutorial sessions)

Additional Readings

	Title
1	Michael Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, Fundamentals of Engineering Thermodynamics, 8th Edition Wiley
2	Yunus A Cengel, Michael A Boles, “Thermodynamics: An Engineering Approach,” 5th Ed., McGrawHill.
3	David Halliday, Robert Resnick, Jearl Walker, “Fundamentals of Physics,” 7th Ed., John Wiley & Sons.