

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE-PILANI- HYDERABAD CAMPUS
SECOND SEMESTER 2022-2023
(COURSE HANDOUT PART II)

Date: 13/03/2023

In addition to part-I (general handout for all courses in the time-table), this handout provides the specific details regarding the course.

Course No.: **BITS F111**

Course Title: **THERMODYNAMICS**

Instructor-in-charge: **Vikranth Kumar Surasani**

Instructors: Ramesh Babu A, Karthik Chetan, R. Parameshwaran, Jeeva Jaidi, Santanu Prasad Datta, KRC Murthy, Arnab Dutta, Debirupa Mitra, Ramendra Pal, Jayaprakash K S

1. **Course Description:** Concepts and laws of thermodynamics, macroscopic thermodynamic properties, application to closed and open systems, microscopic approach to entropy, equations of state, thermodynamics of non-reacting mixtures.
2. **Scope and Objective:** Thermodynamics deals with energy, matter, and the laws governing their interactions. It is essential to learn its usefulness in the design of processes, devices, and systems involving effective utilization of energy and matter. The course emphasizes on the fundamentals and concepts of the laws of thermodynamics as applied to control mass and control volume systems. Irreversibility and availability are powerful tools in the design of thermodynamic systems.
3. **Learning Outcomes:**
 - Understand the fundamentals of thermodynamic systems, processes and cycles, and concepts related to pressure, energy, force, and temperature
 - Solve problems related to pure substances using thermodynamic tables
 - Apply the first law of thermodynamics to solve problems involving different forms of energy, including heat and work for control mass and control volume systems
 - Understand the need for the second law of thermodynamics and its application to control mass and control volume systems
 - Solve problems using the first and second laws of thermodynamics
 - Understand the basic principles of entropy, irreversibility and availability
4. **Text Book:**

T1 Claus Borgnakke & Richard E. Sonntag, “Fundamentals of Thermodynamics”, John Wiley & Sons, 2019, 10th Edition, An Indian Adaption.

T2 Adopted from book by Van Wylen & others “Thermodynamics Tables, Figures and Charts”, Notes-EDD, 2007.
5. **Reference book:**
 - Yunus A Cengel; Michael A Boles ., “Thermodynamics: An Engineering Approach”, McGraw-Hill, 2015, 8th Edition

6. Course Plan:

Topic	Lecture Nos.	Learning Objectives	Topics to be covered	Chapter in the Text Book
Introduction & Preliminaries	1-2	Understand basic concepts and definitions involved in thermodynamics	Introduction, thermodynamic systems, properties & state, process & cycle	T1: 1.1-1.4
			Force, Energy, Pressure, Specific Volume, Zeroth law, Temperature scales.	T1: 1.5-1.4
Properties of Pure Substance	3-4	Understand the properties of pure substances	Phase equilibrium, independent properties, equations of state, compressibility factor.	T1: 2.1 - 2.3, T1: 2.5 - 2.9
	5-7	Use thermodynamic tables to obtain properties of pure substances	Tables of thermodynamic properties & their use.	T2-2.4
Energy Equation and First law of Thermodynamics	8-10	Solve problems related to boundary work	Definition of work and its identification, work done at the moving boundary.	T1:3.3 – 3.4, T1:3.14
	11-12	Differentiate between work and heat	Concept of heat, comparison of heat and work.	T1:3.5 – 3.6
	13-14	Understand the first law of thermodynamics for a control mass and the various forms of energy involved	First law for a cycle as well as for a change of state; internal energy & enthalpy; specific heats, internal energy, enthalpy & specific heat of ideal gases.	T1:3.1 - 3.3, T1:3.7, T1:3.9 -3.11
	15-17	Apply the first law to solve problems for a control mass	Non uniform distribution of states and masses, Transient process;	T1:3.12, 3.13
Energy Analysis for Control Volume	18-20	Differentiate between control mass and control volume. Understand the first law of thermodynamics for a control volume	Conservation of mass in control volume; first law for control volume; Steady State process; examples of Steady State processes, transient processes.	T1:4.1 – 4.4, T1:4.6
	21-22	Apply the first law to solve problems for a control volume	Problem analysis & solution technique; examples.	T1:4.1 – 4.7
The Second Law of Thermodynamics	23-27	Understand the need for Second Law of Thermodynamics and its basic concepts	heat engine, heat pump, refrigerator; Limitations of first law & need for the second law; reversible process; Factors that render irreversibility	T1:5.1 – 5.4
			Carnot cycle; energy-conversion efficiency and COP, Kelvin-Planck & Clausius statements, the thermodynamic temperature scale.	T1:5.5-5.7
			The ideal gas Carnot cycle, Ideal Vs Real machines; The Inequality of Clausius and Engineering applications	T1:5.8-5.11
Entropy	28-34	Understand the physical principles behind entropy and formulation of second law for control mass	Concept of entropy; the need and definition of entropy; entropy of a pure substance; Entropy change of a reversible & irreversible processes;	T1:6.1 - 6.3
			Thermodynamic property relation; Entropy change of solid or liquid; Entropy change of gas The reversible polytropic Process for ideal gas	T1:6.4-6.7
			Entropy Change in of Control Mass & Entropy Balance Equation for a Closed System; The principle of increase in Entropy and Balance equation in rate form.	T1:6.8-6.11

Entropy Analysis for Control Volume	35-37	Understand the formulation of second law for control volume	Second law for control volume; S.S. & transient processes; reversible S.S.S.F. process; principle of increase of entropy	T1:7.1– 7.4
	38-40	Apply the second law of thermodynamics to solve problems for a control volume	Understanding efficiency and related problems; problem analysis & solution technique.	T1:7.5
Exergy	41-43	Understand the physical principles behind Irreversibility and availability	Available energy, reversible work & irreversibility for control mass and control volume processes; second law efficiency.	T1:8.1 – 8.4

7. **Evaluation Scheme:**

DD Evaluation Component	Duration	Notes Weightage (%)	Date & Time	on Nature of Component
Mid semester Test ^{\$}	90 min	25%	03/05 9.30 - 11.00AM	CB
Tutorial Tests	40 min	15%		OB
Quizzes	40 min	15%		CB
Comprehensive Exam ^{\$}	180 min	45%	08/07 FN	CB(15%)+OB(30%)

should not be defaced by writing formula, equations, etc.

8. **Chamber Consultation Hour:** To be announced by the respective instructors.
9. **Notices:** All notices concerning this course shall be displayed on the CMS (the Institute's web based course management system). Besides this, students are advised to visit regularly CMS for latest updates.
10. **Make-up Policy:** Make-up for the mid and comprehensive tests shall be granted only for genuine cases. Requests for the make-up tests, duly forwarded by the respective tutorial section instructors, should reach the IC well before the tests. **For cases related to illness, proper documentary evidence is essential.**
11. **Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor in-Charge
BITS F111**