

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE-PILANI- HYDERABAD CAMPUS**  
**FIRST SEMESTER 2021-2022**  
**(COURSE HANDOUT PART II)**

Date: 30/09/2021

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: **Supradeepan K**

Instructors: Srikanta Dinda, Ramesh Babu A, Vikrant S, Nandini Bhandaru, Pankaj Kumar, Santanu Prasad Datta, Mrinal Ketan Jagirdar, KRC Murthy, R. Parameshwaran

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:**
  - Claus Borgnakke & Richard E. Sonntag, "Fundamentals of Thermodynamics", John Wiley & Sons, 2017, 9<sup>th</sup> Edition.
  - 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:**

Lecture Nos.	Learning Objectives	Topics to be covered	Chapter in the Text Book
1-3	Understand basic concepts and definitions involved in thermodynamics	Introduction, thermodynamic systems, properties & state, process & cycle, force, energy, pressure, specific volume, zeroth law.	1
4-5	Understand the properties of pure substances	Phase equilibrium, independent properties, equations of state, compressibility factor.	2.1 - 2.3, 2.5 - 2.9
6-7	Use thermodynamic tables to obtain properties of pure substances	Tables of thermodynamic properties & their use.	2.4
8-10	Solve problems related to boundary work	Definition of work and its identification, work done at the moving boundary.	3.3 – 3.4, 3.14
11-13	Differentiate between work and heat	Concept of heat, comparison of heat and work.	3.5 – 3.6

Lecture Nos.	Learning Objectives	Topics to be covered	Chapter in the Text Book
14-17	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.	3.1 - 3.3, 3.7, 3.9 - 3.11
18-19	Apply the first law to solve problems for a control mass	Non uniform distribution of states and masses, Transient process;	3.12, 3.13
20-21	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; S.S. process; examples of S.S. processes, transient processes.	4.1 – 4.4, 4.6
22-23	Apply the first law to solve problems for a control volume	Problem analysis & solution technique; examples.	4.1 – 4.7
24-27	Understand the need for Second Law of Thermodynamics and its basic concepts	Limitations of first law & need for the second law; reversible process; heat engine, heat pump, refrigerator; Carnot cycle; energy-conversion efficiency and COP, Kelvin-Planck & Clausius statements, The ideal gas Carnot cycle, the thermodynamic temperature scale.	5.1 – 5.10
28-33	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; principle of increase of entropy, thermodynamic property relation; problem analysis & solution technique.	6.1 - 6.11
34-36	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	7.1– 7.4
37-38	Apply the second law of thermodynamics to solve problems for a control volume	Understanding efficiency and related problems; problem analysis & solution technique.	7.5
39-42	Understand the physical principles behind Irreversibility and availability	Available energy, reversible work & irreversibility for control mass and control volume processes; second law efficiency.	8.1 – 8.4

## 7. Evaluation Scheme:

Evaluation Component	Duration	Weightage (%)	Date & Time*	Nature of Component*
Mid semester Test <sup>§</sup>	90 min	30%	07/12 - 9.00 - 10.30AM	OB*
Tutorial Tests <sup>#</sup>	50 mts	20%	TBA	OB
Assignment <sup>#</sup>	-	10%	TBA	OB
Comprehensive Exam <sup>§</sup>	120 mts	40%	24/01 FN	OB*

\* The mode of conducting the evaluation components may be changed in case the exams are conducted on campus.

# Number of Tutorial Test: 01 (During one tutorial class before Mid semester exam); Number of assignment: 01 (Take home after mid semester exam). All these tests will be announced through notice (on CMS).

§ EDD Notes on "Thermodynamics Tables, Figures and Charts" is allowed in the closed book tests also. However, it 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**