Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2023-2024
Course Handout Part II

Date: 09/01/2024

In addition to Part-I (a general handout for all the courses appended in the time table), this handout gives further specific details of the course.

Course No.   : BITS F111
Course Title   : THERMODYNAMICS
Instructor-in-Charge : Srikanta Dinda
Instructors   : N. Jalaiah, Santanu Prasad Datta, Jayaprakash KS, R Parameshwaran, KRC Murthy, Jaideep Chatterjee, Nandini Bhandaru, Afkham Mir, Ramendra Kishor Pal, Iyman Abrar,

1. **Course Description:**

   Basic concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to thermodynamic systems (closed and open); microscopic approach to estimate the entropy of a system; equation of state; efficiency, irreversibility, and availability of thermodynamic systems.

2. **Scope and Objective:**

   Thermodynamics deals with the matter, energy, and the laws governing their interactions in a given system. Therefore, it is essential to learn its importance in the design and analysis of processes, devices, and systems for effective utilization of energy as well as matter. The course emphasizes the fundamental concepts and the laws of thermodynamics applied to closed systems (control mass) and open systems (control volume). Irreversibility and availability are the powerful tools used in the design and analysis of systems and therefore will be discussed in detail.

3. **Expected Learning Outcome:**

   ✓ Understand the fundamentals of thermodynamic systems - processes and cycles
   ✓ Solve problems related to pure substances using thermodynamic tables
   ✓ Apply the first-law to systems involving heat and work interactions
   ✓ Understand the second-law and its applications - closed and open systems
   ✓ Solve problems using the first and second laws of thermodynamics
   ✓ Understand the basic concepts and principles of the second-law - entropy, irreversibility, and availability

4. **Text Book (TB) and Reference Book (RB):**

   i) Text Book (TB)

   TB: Claus Borgnakke, and Richard E. Sonntag, "Fundamentals of Thermodynamics", Wiley India Pvt. Ltd., 2019, 10th Edition. An Indian Adaptation, Adapted by S. Bhattacharyya & M.K. Soni.

   ii) Reference Book (RB):

a. RB: Yunus A. Cengel, and Michael A. Boles, "Thermodynamics: An Engineering Approach", McGraw-Hill, 2015, 8th Edition.
b. Adoption from books by Van Wylen and others - "Thermodynamics Tables, Figures and Charts", Notes-EDD, 2007.

5. Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter & Sections in TB
1 – 3	Understand the basic concepts and definitions pertaining to thermodynamics (TD)	Introduction, thermodynamic systems, state properties, process & cycle, specific volume, zeroth-law, temperature scales, applications	1.1 – 1.12
4 – 5	Understand the properties of pure substances (as working media)	Pure substance, states, phase equilibrium, independent properties, equation of state, compressibility factor	2.1 – 2.3, 2.5 – 2.10
6 – 7	Use of thermodynamic tables to predict the properties of pure substances	Thermodynamic properties and tables of standard substances (as working fluids)	2.4
8 – 11	Understand the concepts of boundary work and heat transfer and solve problems of control-mass (CM) as a system	Definition of work and heat and their notation, work done at system's boundary, modes of heat transfer	3.1 – 3.6
12 – 15	Understand the first-law of TD for a CM, and other forms of energy involved	First-law for a process; internal energy and enthalpy; specific heats of ideal gases	3.7– 3.11
16 – 18	Apply the first-law of TD to solve problems of CM as a system	First-law as a rate equation; problem analysis and solution technique; examples of closed systems	3.13 – 3.15
19 – 21	Difference between control-mass (CM) and control-volume (CV). Understand the first-law of TD for a CV	Conservation of mass in a control-volume (CV); first-law for a CV; steady-state and transient processes	4.1 – 4.4, 4.6
22 – 23	Application of the first-law of TD for a CV	First-law as a rate equation; problem solving techniques; examples of CVs	4.7
24 – 27	Understand the need for Second-law of TD and its basic concepts	Limitations of the first-law and need of the second-law; reversible process; heat engine, heat pump, refrigerator; Carnot cycle; COP, Kelvin-Planck & Clausius statements; Carnot cycle; thermodynamic temperature scale	5.1 – 5.11
28 – 32	Understand the principles of entropy and second-law of TD for a CM	Concept of entropy; the need and definition of entropy; entropy of a pure substance; entropy change of a reversible and irreversible processes; principle of increase of entropy, thermodynamic property relation; problem solving	6.1 – 6.11
33 – 36	Understand the formulation of second-law of TD for a CM (as a system)	Second-law for a control-volume (CV); steady-state and transient processes; reversible process; principle of increase of	7.1 – 7.5

		entropy	
37 – 39	Application of second-law of TD for a CV	Understanding the efficiency and performance of systems; problem solving	7.5
40 – 42	Understand the principles of Irreversibility and availability	Available energy, reversible work and irreversibility; second-law efficiency	8.1 – 8.4

6. Evaluation Scheme:

Evaluation Component	Duration (min.)	Weightage (%)	Date & Time	Nature of Component
Midsem Test*	90	30	14/03 - 11.00 - 12.30PM	Closed Book
Tutorial Tests	20	20	In tutorial classes	Open Book
Quizzes	15	10	In lecture/ tutorial classes	Open Book
Comprehensive Exam*	180	40	13/05 AN	Closed Book

*EDD Notes on "Thermodynamics Tables, Figures, and Charts" will be allowed. However, it shouldn't be defaced by writing formulas, equations, etc.

7. **Chamber Consultation Hour:** To be announced by the respective lecture/tutorial instructor. Students are encouraged to utilize this opportunity to clear doubts, after attending the regular lecture and tutorial classes.

8. Notices:

All notices concerning this course will be displayed in *CMS (institute's web-based Course Management System)*. Students are advised to visit *CMS* regularly for all the updates.

9. Make-up Policy:

Make-up requests for the Midsem test and Comprehensive exam may be granted only for *genuine* cases with sufficient evidence and with prior approval **from the IC only**. A hard copy of the request letter duly signed by the students must reach to the IC at least two days before the scheduled exam. **No make-up will be allowed for tutorial tests and quizzes.**

10. 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)
Srikanta Dinda