# BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI HYDERABAD CAMPUS

**SECOND SEMESTER 2023-2024**

# Course Handout - Part II

**09-01-2024**

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course

**Course No.:** CHE F241

**Course Title:** Heat Transfer

**Instructor-in-Charge: Dr. Afkham Mir Instructor:** Dr. Afkham Mir

# Course Description

This course covers the theoretical aspects of heat transfer involving conduction, convection and radiation. Topics such as steady and unsteady state conduction, Fourier’s law, heat transfer coefficient, heat transfer in various coordinate systems, insulation, convective heat transfer, theories of heat transfer and analogy between momentum and heat transfer and radiation will be covered. Types of heat exchangers and their design will also be introduced in this course.

# Scope and Objective

The scope of this course is to study the fundamentals of heat transfer. At the end of the course, the student should have

* + A sound understanding of heat transfer fundamentals
  + An ability to apply fundamental heat transfer concepts to chemical engineering problems
  + An understanding of the principles used to design heat transfer equipment in the chemical industry

# Text book (TB):

1. Holman, J.P., “Heat Transfer (10th Ed.)”, Tata McGraw Hill, 2011.
2. McCabe, W.L., J.C. Smith, and P. Harriott, “Unit Operations of Chemical Engineering (7th Ed.)”, McGraw Hill, 2005

# Reference books (RB):

* + **RB1 -** Yunus A. Cengel, “Heat Transfer – a practical approach”, McGraw Hill 2002.
  + **RB2 -** Welty, J.R., C.E. Wicks, R.E. Wilson, and G.L. Rorrer, “Fundamentals of Momentum, Heat and Mass Transfer (4th Ed.)”, John Wiley & Sons, 2001.

# Course Plan

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| **Lecture No.** | **Learning Objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1 – 2 | Basics of Heat Transfer | Introduction to conduction, Thermal conductivity | 1.1 – 1.4 (T1) |
| 3 – 6 | 1-D steady state heat conduction | 1-D steady state heat conduction for Cartesian, Radial and Spherical coordinate system; with and without heat source; Insulation and critical radius of insulation, | 2.1 – 2.8 (T1); Ch  2 (R1) |
| 7 – 8 | Heat Transfer from extended surfaces | Fins and their function; Thermal contact resistance | 2.9 – 2.11 (T1); Ch  3 (R1) |
| 9 – 11 | 1 –D unsteady-state conduction | Lumped heat capacity system, Transient heat flow in a semi-infinite solid, Convective boundary conditions | 4.1 – 4.4 (T1);Ch  4 (R1) |

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| 12 – 19 | Principles of convection | Viscous flow, Inviscid flow, Laminar and turbulent boundary layer, Heat transfer in boundary layer - Energy equation of the boundary layer and thermal boundary layer | 5.1 – 5.2 ,5.5 –  5.11 (T1); Ch. 11  and 12 T2; Ch 6 (R1) |
| 20 – 22 | Forced convection heat transfer | Empirical relations for pipe and tube flow, Flow across cylinders and spheres. | 6.1 – 6.3 (T1); Ch  12 T2, Ch 7 (R1) |
| 23 – 26 | Natural convection Systems | Theory and empirical relations for free convection from different geometric configurations such as plates, cylinder, sphere; Combined free and forced convection. | 7.1 – 7.12 (T1); Ch  12 T2, Ch 8-9 (R1) |
| 27 – 29 | Radiation heat transfer | Mechanism and properties of radiation, Black body and gray body radiation, shape factor, Radiation shield, Radiation heat transfer coefficient | 8.1 – 8.5, 8.8, 8.17 (T1); Ch 14 T2; Ch 12 (R1) |
| 30 – 34 | Heat exchangers | Overall HT coefficient, Types of heat exchangers, LMTD, effectiveness, Co-current and counter-current flows, Design considerations | 10.1 – 10.9 (T1);  Ch 15 (T2); Ch 13 (R1) |
| 35-39 | Condensation and boiling heat transfer | Condensation phenomena, Film condensation, Boiling heat transfer, The heat pipe | Ch. 9.1- 9.6 (TB)  Ch 13 (T2); Ch 10 (R1) |
| 40-41 | Course revision | Course revision | - |

1. **Evaluation Scheme**

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| **Evaluation Component** | **Duration** | **Weightage (%)** | **Date, Time** | **Nature of Component** |
| Mid Semester Test | 90 min | 20 | 15/03 - 9.30 - 11.00AM | Closed book |
| Surprise Test (Min 5) | 15 mins each | 25 | Continuous Evaluation | OB |
| Assignment (1) | - | 15 | TBA | OB |
| Comprehensive Examination | 180 min | 40 | 16/05 FN | OB |

1. **Chamber Consultation Hour**: **(Chamber D-318)**. Tuesday 9 am to 10 am
2. **Notices:** Course-related notices will be uploaded on the CMS website
3. **Makeup exam Policy:** Make-up requests for the Midsem and Comprehensive exam may be granted only for genuine cases with sufficient evidence and with prior approval. No make-up will be allowed for tests and viva.

# 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.

Dr. Afkham Mir **Instructor–in-Charge CHE F241**