

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, GOA CAMPUS**  
**INSTRUCTION DIVISION**  
**SECOND SEMESTER 2018-2019**  
**Course Handout for Heat Transfer Operations**

**Course No.** : CHE F241  
**Course Title** : Heat Transfer  
**Instructor-in-Charge** : Sutapa Roy Ramanan  
**Instructor** : Sutapa Roy Ramanan /

**1. Course Description**

Steady and unsteady state heat conduction; forced and natural convection; radiation; condensation and boiling heat transfer; evaporation; heat exchangers and associated laboratory.

**2. Scope and Objective**

This course is aimed at studying the basic fundamentals of heat transfer and their practical applications, which is an integral part of the chemical engineering education. This course covers the theoretical aspects as well as experimental analysis of heat transfer operations involving conduction, convection and radiation. Another objective of the course is to give the students an idea of the design of heat transfer equipment such as heat exchanges and evaporators used frequently in chemical industry.

**3. Text book (TB):**

1. Holman, J.P., "Heat Transfer", 9<sup>th</sup> Edition, McGraw Hill, 2002

**4. Reference books (RB):**

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of heat and mass transfer" 6<sup>th</sup> Edition, Wiley, 2007
2. McCabe, W.L., J.C. Smith, and P. Harriott, "Unit Operations of Chemical Engineering", 6<sup>th</sup> Edition, McGraw Hill, 2001
3. Bird, R.B., W.E. Stewart, and E.N. Lightfoot, "Transport Phenomena", John Wiley & Sons, 1994
4. Welty, J.R., C.E. Wicks, R.E. Wilson, and G.L. Rorrer, "Fundamentals of Momentum, Heat and Mass Transfer", 4<sup>th</sup> Edition, John Wiley & Sons, 2001

**5. Course Plan**

Lecture No.	Learning Objectives	Topics to be covered	Reference
1 – 5	Basics of Heat Transfer	, Introduction to conductive, convective and radiation heat transfer, energy balance	Ch. 1 (Sec. 1.1 -1.4) TB
6 – 11	One dimensional steady state conduction phenomena	One dimensional steady state conduction for Cartesian, radial and spherical coordinate system, with and without heat source, fin theory and thermal contact resistance	Ch. 2 (Sec. 2.1 - 2.11) TB
12 – 14	One dimensional	Lumped heat capacity system,	Ch. 4 (Sec. 4.1 - 4.4) TB

	unsteady state conduction	transient heat flow in a semi-infinite solid, convective boundary conditions, Biot and Fourier numbers	
15 - 19	Principles of convection	Viscous flow, Inviscid flow; laminar and turbulent boundary layer, boundary layer heat transfer	Ch. 5 (Sec. 5.1 - 5.11) TB
20 – 23	Empirical and practical relations for forced convection heat transfer	Empirical relations for pipe and tube flow, flow across cylinders and spheres, flow across tube banks, Liquid metal heat transfer	Ch. 6 (Sec. 6.1 - 6.5) TB
24 – 27	Natural convection	Theory and empirical relations for free convection from different geometric configurations such as plates, inclined surface, cylinder, sphere etc., Combined free and forced convection	Ch. 7 (Sec. 7.1 - 7.12) TB
28 – 30	Radiation heat transfer	Mechanism and properties of radiation, Shape factor, Black body and gray body radiation, Gas radiation, Radiation shield, Radiation network	Ch. 8 (Sec. 8.1 - 8.12) TB
31 – 35	Condensation and boiling heat transfer	Theory and empirical relations for film wise condensation and boiling phenomena	Ch. 9 (Sec. 9.1 to 9.7) TB
36- 40	Heat exchangers	Concept of overall heat transfer coefficient, LMTD method, effectiveness - NTU method, and Kern's method for heat exchanger design; Compact heat exchangers	Ch. 10 (Sec. 10.1 to 10.9) TB; Ch. 15 RB 2

### Evaluation Scheme

Evaluation Component	Duration	Weightage	Date	Nature of Component
Midterm	90 min	30%	13.03.19, Wednesday 4.00 AM- 5.30 PM	CB
Surprise quiz / Assignment / Tutorial test / Attendance	***.	30%	To be announced in class	OB
Comprehensive Examination	3 hrs	40%	7/05/19 (AN)	OB

C.B. - Closed book; O.B. - Open book

- The date, time and venue of Midterm and comprehensive exam is mentioned in the Time-table. The Surprise quiz / Assignment / Tutorial test / Attendance evaluation will be at the discretion of the Instructor-in- Charge and will be informed in class at the start of the Semester.

- Chamber consultation hours will be announced in the class.
- The notices will be displayed on Engineering Notice Board – Wing A.
- Make-up will be granted for genuine cases only. Prior permission of IC is compulsory.

**Instructor-in-Charge**  
**CHE F241**