SECOND SEMESTER 2015-2016

Course Handout (Part II)

Date: 06/01/2015

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 Operation**
Instructor-in-Charge	**:**	**SONAL MAZUMDER**
Instructors (Tutorial)	**:**	**Sonal Mazumder & Ajaya K. Pani**

1. Course Description

Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius, Convective heat transfer in laminar and turbulent boundary layers, Theories of heat transfer and analogy between momentum and heat transfer, Heat transfer by natural convection, Boiling and condensation, Radiation, Heat exchangers: LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation

2. Scope & Objective

The course will introduce the fundamental concepts of various modes of heat transfer. It will further elaborate these concepts with theories and applications to the solutions of practically relevant chemical engineering problems. Some aspects of process design principles of various heat transfer equipment will be taken up in the later part of this course. Finally, to present a physical picture of the convection process, heat transfer in boundary layer flows will be addressed. Even though the course is primarily designed to meet the requirements of an undergraduate chemical engineering course on heat transfer, it will be useful for the practicing engineers to refresh with fundamental and technical information.

3. Text Book (TB)

Holman, J.P., "Heat Transfer (10^h Ed.)", McGraw Hill, 2004.

Reference Books (RB)

RB1 McCabe, W.L., J.C. Smith, and P. Harriott, "Unit Operations of Chemical Engineering (7^{th} Ed.)", McGraw Hill, 2001.
RB2 Bird, R.B., W.E. Stewart, and E.N. Lightfoot, "Transport Phenomena", John Wiley & Sons, 1994.
RB3 Welty, J.R., C.E. Wicks, R.E. Wilson, and G.L. Rorrer, "Fundamentals of Momentum, Heat and Mass Transfer (4^{th} Ed.)", John Wiley & Sons, 2001.
RB4 Kern, D.Q., "Process heat transfer", Tata McGraw Hill Edition, 1997.

4. Course Plan

Lecture No.	Learning Objectives	Topics to be covered	Reference (TB) Ch. / Sec. #
1	Basics of Heat Transfer	Introduction to conductive, convective and radiative heat transfer	Ch. 1 (Sec. 1.1 to 1.4) TB
2 – 7	One dimensional steady state conduction	One dimensional steady state conduction for cartesian, radial and spherical coordinate systems with and without heat source, Fins, Thermal contact resistance	Ch. 2 (Sec. 2.1 to 2.11) TB
8 – 11	One dimensional unsteady state conduction	Lumped heat capacity system, Transient heat flow in a semi-infinite solid, Convective boundary conditions, Multidimensional system	Ch. 4 (Sec. 4.1-4.5) TB
12 – 16	Principles of convection	Viscous flow; Inviscid flow; Laminar and turbulent boundary layer; Boundary layer heat transfer	Ch. 5 (Sec. 5.1 to 5.11) TB
17 – 18	Empirical and practical relations for forced convection heat transfer	Equations for empirical relations for pipe and tube flow; Equations for flow across cylinders and spheres; Flow across tube banks; Liquid metal heat transfer	Ch. 6 (Sec. 6.1 to 6.5) TB
19 – 22	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 to 7.12) TB
23 – 26	Radiation heat transfer	Mechanism and properties of radiation; Shape factor; Back body and gray body radiation; Gas radiation; Radiation shield; Radiation network	Ch. 8 (Sec. 8.1 – 8.12) TB
27 – 31	Condensation and boiling heat transfer	Theory and empirical relations for film and dropwise condensation and boiling phenomena; Heat pipe	Ch. 9 (Sec. 9.1 to 9.7) TB
32 - 36	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 1, Ch. 6 & 7 (RB 4)
37 – 40	Evaporation	Types of evaporators; Evaporator capacity and economy; Single and multiple effect evaporators	Ch. 16 (RB 1)

5. Evaluation Scheme

EC No.	Evaluation Component (EC)	Duration	Weightage (Marks)	Date, Time	Remarks
1	Mid Semester Test	80 min	26% (80)	16/3 2:00 -3:30 PM	CB
2	Surprise tests T*	15 min	20% (60)	-	CB/OB
3	Surprise tests C*	15 min	17% (50)	-	CB/OB
5	Comprehensive Exam	3 hrs	37% (110)	9/5 FN	CB + OB

CB = Close Book **OB** = Open Book

*__Surprise tests T__ will be conducted during tutorial hours. Best **six** performances out of eight will be considered for final grading.

*__Surprise tests C__ will be conducted during lecture hours. **Five** tests will be conducted throughout the semester. No buffers for these tests will be allowed.

Chamber consultation hour will be announced in the class. Please email for making prior appointment.

- The **notices,** if any**,** concerning the course, will be displayed on the notice board of the Department of Chemical Engineering **only** AND/OR updated in Nalanda and email to the class.
- **Make-up** for mid-semester and comprehensive exams will be granted for **genuine cases only**. Certificate from authenticated doctor, say from the Medical Center, must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). Prior permission of IC is compulsory.
- No make up for tutorial/class tests.
- Mobile phones, exchanging materials or calculator, any misconduct and indiscipline will not be allowed during tests.

Instructor-in-charge | **CHE F241**