Heat Transfer Operations

1.1 Course Number: CH231

1.2 Contact Hours: 3-1-2 Credits: 13

1.3 Semester-offered: 2nd Year-Odd

1.4 Prerequisite: Fluid Mechanics (CH121)

1.5 Syllabus Committee Member: Dr. Milan Kumar, Dr. Rakesh Kumar, Dr. Shweta

2. **Objective:** The course will provide fundamental understanding of heat transfer operations, and related equations and correlations, which will be used for designing equipment. The subject will also offer hands-on experience to the students through related experiments to deepen their learning of the topics.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub topics	Lectures
1	Conduction	Modes of heat transfer, Fourier's laws, thermal conductivity, steady state conduction, conduction-convection systems, insulation, extended surfaces, unsteady state conduction, Lump-heat-capacity system, Heisler's charts	9
2	Radiation	Introduction to radiation, blackbody radiation, shape factors, heat exchange between surfaces and equivalent circuit, radiation shields, and equivalent circuits, gas radiation	9
3	Convection without phase change	Convective heat transfer for internal and external laminar flows Convective heat transfer for turbulent flows, Reynolds-Colburn analogy, empirical correlations Natural convection, empirical relations for different geometries and orientations	10
4	Convection with phase change	Condensation: film-wise and drop-wise condensation, correlations Boiling: pool and convective boiling, correlations	4
5	Heat transfer equipment	Classification of heat transfer equipment, double pipe and Shell & Tube heat exchangers, Fouling factors, Kern's method and ε-NTU method, heat transfer to jacketed vessels and agitated vessels, Evaporators	8
		Total	**40**

Laboratory classes: There will be 10-12 experiment designed based on the theory covered in the lectures to provide hand-on experience and in-depth understanding of the heat transfer processes.

4. Readings

4.1 Textbooks:

1. J.P. Holman, *Heat Transfer*,10th Ed., McGraw Hill, New York, 2010.
2. Y.A. Cengel and A.J. Ghajar, *Heat and Mass Transfer: Fundamentals and Applications*, 6th Ed., McGraw Hills, 2020.
3. R.K. Sinnott, *Chemical Engineering Design*, Coulson and Richardson's Chemical Engineering Series, Vol. 6, 4th Ed., Elsevier Butterworth-Heinemann, 2005.

4.2 Reference books:

1. F.P. Incropera, D.P. Dewitt, T.L. Bergman and A.S. Lavine, Principles of Heat and Mass Transfer, 7th Ed., Wiley, 2016.
2. J.R. Welty, C.E. Wicks, R.E. Wilson and G. Rorrer, *Fundamentals of Momentum, Heat, and Mass Transfer*, 7th Ed., Wiley, New York, 2019.
3. L. Theodore, *Heat Transfer Applications for the Practicing Engineer*, Wiley, NJ, 2011.
4. D.Q. Kern, *Process Heat Transfer*, McGraw-Hill Book Co., Inc., New York, 2017.

5 Outcome of the Course: The students will be knowledgeable about the modes of heat transfer. Through calculations, they can calculate heat utilization and heat loss in any heat transfer equipment. They will be also accomplished in designing and sizing a heat exchanger for an application. Through experiments, students will be able to get to know the operation of various heat transfer systems and their internals.