Heat Transfer Operations

1.1 Course Number: CH231

1.2 Contact Hours: 3-1-0 Credits: 11

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 principles, and related equations and correlations, which will be used for designing the process 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	Introduction of heat transfer principles, thermal conductivity, steady state conduction: 1D, 2D and 3D, conduction-convection systems, insulation, extended surfaces/fins, unsteady state conduction, lump-heat-capacity system, Heisler’s charts	6
2	Radiation	Stefan-Boltzamann law, radiation properties, radiation from black, gray and real bodies, shape factors, heat exchange between surfaces and equivalent circuit, radiation shields, gas radiation	7
3	Convection without phase change	Heat transfer on flat plate (laminar flow): thermal boundary layer, heat transfer coefficient Heat transfer in pipe flows (laminar flow): thermal boundary layer, heat transfer coefficient Heat transfer for turbulent flows on plate and in tubes, Reynolds-Colburn analogy, empirical correlations Natural convection: thermal boundary layer, empirical relations for different geometries and orientations	10
4	Convection with phase change	Condensation: film-wise condensation, Nusselt equation, drop-wise condensation, condensation number, correlations Boiling: pool and convective boiling, critical heat flux, correlations	5

5	Heat transfer equipment	Classification of heat transfer equipment, double pipe and shell & tube heat exchangers, fouling factors, single and multiple passes, and correction factors, Selection of materials, internals and design of heat exchanger, Kern's method and ε-NTU method, Pinch Technology	12
		Total	**40**

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.

1. **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.