DESIGN OF HEAT EXCHANGERS
(Professional Elective - III)

II Semester

Course Code: 19ME2255

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Prerequisites: Heat Transfer

Course Outcomes: At the end of the course the student shall be able to

CO1: Classify and design heat exchangers.
CO2: Estimate convective heat transfer in ducts, concentric annuli, circular pipes.
CO3: Determine pressure drop and effect of fouling in heat exchangers.
CO4: Design double pipe heat exchangers and compact heat exchangers by considering fin effects.
CO5: Design shell and tube heat exchangers and condensers for application in refrigeration and air-conditioning.

UNIT-I: **(10-Lectures)**

Classification of heat exchangers: Tubular heat exchangers, plate heat exchangers, extended surface heat exchangers, flow arrangements, applications.
Basic design methods of heat exchangers: Overall heat transfer coefficient, multi pass and cross flow heat exchangers, Log Mean Temperature Difference (LMTD) method, effectiveness-Number of Transfer Units (NTU) method for heat exchanger analysis, heat exchanger design calculations, heat exchanger design methodology.

Learning outcomes: At the end of this unit, the student will be able to

1. List different types of heat exchangers (L1)
2. Determine the overall heat transfer coefficient. (L5)
3. Demonstrate LMTD and effectiveness-NTU method. (L2)

UNIT-II: **(10-Lectures)**

Correlations for forced convection heat transfer coefficients: Laminar forced convection in ducts and concentric annuli, turbulent forced convection in circular pipes, heat transfer in helical coils and spirals, heat transfer in bends.

Learning outcomes: At the end of this unit, the student will be able to

1. Solve laminar heat transfer coefficients in ducts and concentric annuli. (L3)
2. Demonstrate heat transfer in turbulent forced convection in circular pipes. (L2)
3. Analyse heat transfer in helical coils, spirals and in bends. (L4)

UNIT-III: ` **(10-Lectures)**

Heat exchanger pressure drop and pumping power: Tube side pressure drop in laminar and turbulent flows, pressure drop in helical and spiral coils, pressure drop in bends and fittings. Fouling of heat exchangers: Basic considerations, effect of fouling on heat transfer and pressure drop, aspects of fouling, design of heat exchangers subject to fouling.

Learning outcomes: At the end of this unit, the student will be able to

1. Determine pressure drop and pumping power in laminar and turbulent flows. (L5)
2. Discuss pressure drop in helical, spiral coils and bends. (L6)
3. Explain effect of fouling in heat exchangers. (L2)

UNIT-IV: (10-Lectures)

Double pipe heat exchangers: Pressure drop, hydraulic diameter, hairpin heat exchanger, parallel and series arrangements of hairpins, total pressure drop.
Compact heat exchangers: Plate-fin heat exchangers, tube fin heat exchangers, heat transfer and pressure drop for finned-tube heat exchangers, pressure drop for plate-fin heat exchangers.

Learning outcomes: At the end of this unit, the student will be able to

1. Design hairpin heat exchanger. (L6)
2. Develop compact heat exchangers. (L6)
3. Determine total pressure drop in heat exchangers. (L5)

UNIT-V: (10-Lectures)

Shell and tube heat exchangers: Basic components, basic design procedure of a heat exchanger, shell-side heat transfer and pressure drop, Bell Delaware's method.
Condensers: Horizontal shell-and-tube condensers, horizontal in-tube condensers, plate condensers, air cooled condensers, thermal design of shell-and-tube condensers, design and operational considerations.

Learning outcomes: At the end of this unit, the student will be able to

1. Design shell and tube heat exchanger. (L6)
2. Determine shell side heat transfer. (L5)
3. Classify condensers. (L2)

TEXT BOOKS:

1. Sadik Kakac and Hongtan Liu, *Heat Exchangers: Selection, Rating and Thermal Design*, Third Edition, CRC Press, New York, USA, 2012.

REFERENCE BOOKS:

1. Donald Q. Kern, *Process Heat Transfer*, Tata McGraw-Hill, 2001.
2. *Standards of the Tubular Exchanger Manufacturer Association (TEMA)*, Inc., Ninth Edition, New York, 2007.