19FT211 FUNDAMENTALS OF HEAT AND MASS TRANSFER

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
25	50	-	-	5	5

Source:

https://www.ukexchangers.com/heat-exchange-products/tube-in-tube-heat-exchangers

COURSE DESCRIPTION AND OBJECTIVES:

This course deals on imparting fundamental understanding on the phenomena of heat and mass transfer. The objective of this course is to train students on principles of heat and mass transfer, methodologies for determining the rate of heat and mass transfer and perform heat exchanger design calculations.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the basic laws of heat and mass transfer.	1
2	Design suitable insulation for heat exchange equipment.	3
3	Formulate equations to calculate the heat transfer coefficient .	2
4	Identify the suitable heat exchanger for a given process.	3
5	Analyse heat exchanger performance.	2
6	Understand various mass transfer operations.	1

SKILLS:

- ✓ *Estimate the rate of heat flow through a wall, cylinder or sphere.*
- ✓ *Insulation thickness estimation.*
- ✓ *Determine heat transfer coefficients.*
- ✓ *Estimate double pipe heat exchanger length required for specified conditions.*
- ✓ *Perform basic calculations required for heat exchanger design.*
- ✓ *Select the correct type of heat exchanger required for a specific process.*
- ✓ *Determine the emissivity of a body.*

UNIT - I **L-9**

HEAT TRANSFER AND ITS APPLICATIONS: Nature of heat flow-conduction, convection, radiation; Heat transfer by conduction-fourier's law, one dimensional heat flow through slab/cylinder/sphere derivation, concept of electrical analogy, thermal resistance of slab/cylinder/sphere, heat flow through composite wall/cylinder and sphere, thermal contact resistance, industrial applications of composite walls.

UNIT - II **L-9**

CONVECTION: Heat flow by convection-natural convection and forced convection, newton's law of cooling, heat transfer coefficient, concept of overall heat transfer coefficient, critical thickness of insulation; Dimensional analysis-buckingham pi theorem, dimensionless numbers for heat transfer by natural convection and forced convection using buckingham pi theorem, significance of dimensionless numbers; Concept of thermal boundary layers; Important correlations in forced and natural convection.

RADIATION: Heat flow by radiation-absorptivity, transmissivity, reflectivity, black body, white body, grey body, Stefan-Boltzmann law, emissivity, Kirchhoff's law, equation for rate of heat transfer between two bodies (black bodies & non black bodies), shape factors.

UNIT - III **L-9**

HEAT EXCHANGER: Heat exchange equipment-counter currents and parallel currents flows, energy balances, rate of heat transfer, LMTD, individual heat transfer coefficient, overall heat transfer coefficient, fouling factors, shell and tube and plate heat exchangers; Heat exchanger design; Application of different types of exchangers in food industry.

UNIT - IV **L-9**

BOILING AND CONDENSATION: Boiling heat transfer-types of boiling, pool boiling of liquid, critical heat flux concept, pool boiling of saturated liquids, film boiling; Condensation heat transfer-drop wise and film type condensation; Evaporators-falling film evaporator, climbing film evaporator, forced circulation evaporator, multiple effect evaporator, methods of feeding in multiple effect evaporator; Application of different evaporators in food industry.

UNIT - V **L-9**

MASS TRANSFER: Introduction-fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolar counter diffusion, mass transfer coefficient; Qualitative discussion on various mass transfer operations-distillation, liquid liquid extraction, leaching, absorption and adsorption.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS **TOTAL HOURS: 30**

1. Determination of heat transfer coefficient by natural convection.
2. Determination of overall resistance in composite wall.
3. Emissivity measurement.
4. Determination of thermal conductivity of metal rod.
5. Determination of heat transfer coefficients of double pipe heat exchanger.
6. Determination of critical heat flux points of Nichrome Wire.
7. Shell and Tube heat exchanger.
8. Liquid-liquid diffusivity experiment.
9. Surface evaporation experiment.
10. Gas-diffusivity measurement experiment.

TEXT BOOK:

1. R. K. Rajput, "Heat and Mass Transfer", 5th edition, S. Chand and Co. Ltd, 2008.

REFERENCE BOOKS:

1. Y. A. Cenger and A. Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", 5th edition, McGraw Hill India, 2014.
2. A. S. Lavine, F. P. Incropera, D. P. DeWitt and T. L. Bergman, "Fundamentals of Heat and Mass Transfer", 7th edition, Wiley India, 2011.
3. R. E. Treybal, "Mass Transfer Operations", 3rd edition, McGraw-Hill Book Company, 1980.