17FT018 HEAT & MASS TRANSFER OPERATIONS IN FOOD PROCESSING

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	30	-	5	5	-

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:

The student will be able to:

- understand the basic laws of heat and mass transfer.
- account for the consequence of heat transfer in thermal analyses of engineering systems.
- analyze problems involving steady state heat conduction in simple geometries
- obtain numerical solutions for conduction and radiation heat transfer problems.
- understand the fundamentals of convective heat transfer process.
- know about the basic mechanism behind boiling and condensation processes.

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.

UNIT-I

Conduction heat transfer: Introduction to heat and mass transfer and their analogous behaviour - steady and unsteady state heat conduction - analytical and numerical solution of unsteady state heat conduction equation - use of Gurnie-Lurie and Heisler Charts in solving problems on conduction heat transfer - applications in food processing including freezing and thawing of foods.

UNIT-II

Convective heat transfer: Convective heat transfer in food processing systems involving laminar and turbulent flow- heat transfer in boiling liquids- regimes of boiling - nucleate boiling - film boiling equation - heat transfer between fluids and solid foods - natural convection over vertical cylinders, inclined surfaces, horizontal cylinders, cylinder with axis perpendicular to flow - single sphere - banks of tubes – forced convection – boundary layer diffusion equations and convention regimes - solving numerical in forced convection.

UNIT-III

Heat exchanger: Design of heat exchanger - parallel and counter flow – types - plate heat exchanger, shell and tube type heat exchanger, scrapped surface heat exchanger and jacketed vessels - functional design of heat exchanger – solving problems on heat exchangers.

UNIT-IV

Radiation heat transfer: Diffused radiation - angle factor - rate of radiant loss - absorption factor method - uniform radiation - assumption for emissivity determination –Kirchhoff's law- radiation heat transfer –Plank's law black body radiation emissivity and absorptivity - radiation heat transfer coefficient - black bodies - grey bodies, combined radiation and convection heat transfer - radiation surface coefficient - applications in food processing.

UNIT – V

Mass transfer: Mass transfer-molecular diffusion in gases, liquids, solids, biological solutions and suspensions - unsteady statemass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

TEXT BOOKS:

1. Bird R. Byron,Warren E. Stewart and Edwin N. Lightfoot. 2006. Transport Phenomena.Wiley India Pvt. Ltd., New Delhi.
2. Earle, R.L. 1985. UNIT Operations in Food Processing. Pergamon Press, UK
3. Geankoplis J. Christie. 1999. Transport Process and UNIT Operations. Third Edition, Prentice Hall of India, NewDelhi.

REFERENCE BOOKS:

1. McCabe L.Warren, Smith C. Jullian and Peter Harriott.1993. UNIT Operations of Chemical Engineering. McGraw Hill Inc. New York.
2. Paul Singh, R. and Dennis R. Heldman. 2004. Introduction to Food Engineering. Elsevier India Pvt. Ltd., NewDelhi.
3. Sinnott, R.K.2000. Coulson and Richardson's Chemical Engineering. Volume VI. Butterworth Heinemann, New delhi.

ACTIVITIES:

- Effect of radiation on test tube filled with water.
- Connecting shell and tube heat exchanger setup
- Design of shell and tube heat exchanger