DETAILED SYLLABUS

I-Year, I-Semester	L	T	P	Credits: 4
	3	1	-	

CH551 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING

UNIT-I

Principles of fluid flow: Basic engineering mathematics - units and dimension-conservation of mass and energy – principles of fluid flow – properties of liquids, fluid dynamics - mass and energy balance- potential energy, kinetic energy, pressure energy, friction loss, mechanical energy-Newtonian and non – Newtonian fluids-stream line and turbulent flow - flow measurement and measurement of viscosity.

UNIT-II

Evaporation and distillation: Blanching, pasteurization-LTLT, HTST and UHT process-evaporation – definition-single and multiple effect evaporator – mass and enthalpy balance – liquid characteristics – single and multiple effect evaporation-performance of evaporators and boiling point elevation – capacity – economy and heat balance-types of evaporators –short tube evaporators and long tube evaporators – agitated film evaporator - distillation - methods – flash distillation and differential distillation – steam distillation - distillation with Reflux and McCabe – Thiele method- Raleigh equation-fractional distillation -steam requirements in food processing industries.

UNIT-III

Separation process: Sedimentation – gravitational sedimentation - Stoke's law - sedimentation of particles in fluids - cyclones – settling under sedimentation and gravitational sedimentation-centrifugal separations – rate of separations – liquid – liquid separation – centrifuge equipment - filtration –filter media – types and requirements-constant rate filtration – constant pressure filtration – filter cake resistance filtration equipment – rotary vacuum filter – filter press - membrane technology- classification – dialysis -gas permeation membrane process – types of membrane – equipments-Reverse osmosis membrane process – flux equation –ultra filtration membrane process – fluid equation – effects of processing variables filtration.

UNIT-IV

Contact equilibrium process: Concentrations - gas/liquid equilibria, solid/liquid equilibria,-equilibrium concentration relationships - operating conditions- applications - gas absorption-rate of gas absorption- properties of tower packing – types – construction – flow through packed towers -extraction and washing – extraction equipments- washing – equipments and equilibrium diagram - equipment for leaching coarse solids – intermediate solids – crystallization - rate of crystal growth- crystallization equipments.

UNIT-V

Material handling, size reduction and mixing: Material handling equipments- screw conveyor, bucket elevator, belt conveyor, chain conveyor, pneumatic conveyor-size reduction process- energy and power requirements in comminuting- Rittinger's, Bond's and Kick's laws of crushing - principles of milling equipments - hammer mill, attrition mill- pin mill, ball mill - homogenization principles - mixing – types of mixers –kneaders and blenders - gas liquid mixing – liquid solid mixing – applications – food plant layout and design - concepts-

food plant hygiene - cleaning sterilizing waste disposal methods - food packaging – functions, technique - machinery and equipment.

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. London
3. Geankoplis J. Christie. 1999. Transport Process and Unit Operations. Third Edition, Prentice Hall of India, New Delhi.
4. McCabe L. Warren, Smith C. Jullian and Peter Harriott.1993. Unit Operations of Chemical Engineering. McGraw Hill Inc. New York.
5. Paul Singh, R. and Dennis R. Heldman. 2004. Introduction to Food Engineering. Elsevier India Pvt. Ltd., New Delhi.
6. Sinnott, R.K.2000. Coulson and Richardson's Chemical Engineering. Volume VI. Butterworth Heinemann, New Delhi.