

**THIRD SEMESTER****FQA 231      3 (2+1)****Food Biochemistry and Human Nutrition****(32 lectures + 16 Practical)**

<b>Unit 1</b>	<b>Concepts of food and nutrition</b> Definition of terms – nutrition, malnutrition (undernutrition, overweight, obesity), health and nutritional status, functions of food, basic food groups – energy yielding, body building and protective, nutrients supplied by food, nutritional needs – requirements and recommended allowances of foods under normal conditions for all age groups
<b>Unit 2</b>	<b>Mechanism of enzyme action</b> Introduction to enzymes, coenzymes, regulation of enzymatic activity, enzyme kinetics, inhibition effects of pH, allosteric enzymes, derivation of Michaelis-Menten Equation
<b>Unit 3</b>	<b>Nucleic acids</b> Definition and composition of RNA and DNA, structure of various components, viz, bases and sugars, hydrolysis of nucleic acids, structure of RNA and double helical structure of DNA
<b>Unit 4</b>	<b>Nutrients</b> Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings
<b>Unit 5</b>	<b>Metabolism of carbohydrates</b> Biological role of carbohydrates, glycolysis and respiration (TCA cycle), production of ATP- a brief description of electron transport chain, oxidative and substrate phosphorylation
<b>Unit 6</b>	<b>Metabolism of lipids</b> Biological role of lipids, breakdown of triglycerides and phospholipids, $\beta$ -oxidation of long chain fatty acids, ketosis, biosynthesis of fatty acids, triglycerides and phospholipids
<b>Unit 7</b>	<b>Metabolism of proteins</b> Breakdown of proteins, transamination, deamination, decarboxylation, nitrogen fixation, urea cycle
<b>Unit 8</b>	<b>Minerals</b> Functions, sources, factors affecting absorption of minerals, absorption promoters – Vit C for Fe, absorption inhibitors – phytates, tannins, oxalates, effect of deficiency – Calcium, phosphorus, iron, zinc, iodine, fluorine and copper
<b>Unit 9</b>	<b>Vitamins and hormones</b> Classification, functions, sources, effects of deficiency, fat soluble vit (A,D,E,K), water soluble vitamin (thiamine, riboflavin, niacin, cyanocobalamin, folic acid, and ascorbic acid), relationship between vitamins and hormones in terms of their biological role
<b>Unit 10</b>	<b>Physico chemical and nutritional changes during processing</b> Changes during food processing treatment – drying and dehydration, irradiation, freezing, fermentation, canning, restoration, enrichment, fortification and supplementation of foods
<b>Practical</b>	<b>Title</b>
1	Safety in biochemistry laboratory
2	Measurement of energy using bomb calorimeter
3	Determination of pKa of acid
4	Determination of pI for casein
5	Estimation of sugars by Anthrone method
6	Estimation of protein by Lowry method
7	Estimation of amino acid using Biuret reaction
8	Separation of amino acids using paper chromatography
9	Separation of amino acids using Thin layer Chromatography
10	Separation of amino acids using electrophoresis
11	Estimation of phosphorus in food sample
12	Estimation of iron content in foods
13	Determination of calcium in food samples

- 14 Estimation of  $\beta$  – carotene using column chromatography
- 15 Estimation of ascorbic acid using dye method
- 16 Effects of acids and alkali on pigments

**Text books**

- 1 Principles of Biochemistry *by* A L Lehninger
- 2 Text book of Biochemistry *by* E S West, W R Todd, H S Mason and J T Van Bruggen
- 3 Nutrition and Dietetics, Tata McGraw-hill Co. Ltd *by* Shubhangini A Joshi

**Reference books**

- 1 General Biochemistry *by* J H Weil
- 2 Biochemistry of Foods, Academic Press *by* A M Eskin
- 3 Food Chemistry, Marcel Dekkar Inc *by* O R Fennema
- 4 Essentials of Nutrition, Ganesh and Co *by* M Swaminathan
- 5 Outlines of biochemistry *by* Eric E Conn and P K Stumpf

**FPE 231            3 (2+1)**  
**Fluid Mechanics**

**(32 Lectures + 16 Practical)**

<b>Unit 1</b>	<b>Introduction and Properties of Fluids</b> Properties of Fluids: Concept of fluid mechanics, definition of fluid, fluid continuum, density, specific weight Viscosity: Newtonian and Non-Newtonian fluids, kinematic viscosity, dynamic viscosity, variation of temperature with viscosity Surface tension, vapour pressure, incompressible and compressible fluids, ideal and real fluids
<b>Unit 2</b>	<b>Fluid Mechanics</b> Pressure Measurement: Static pressure of liquids, absolute and gauge pressures, mechanical pressure gauges, pressure measurement by manometers Forces on plane surfaces, forces on curved surfaces, Buoyant forces (Archimedes' Principle), stability of floating and submerged bodies.
<b>Unit 3</b>	<b>Kinematics of Fluid Motion</b> Classification of Flow: Method of describing fluid motion, classification of flow: steady and unsteady; uniform and non-uniform; one, two and three dimensional flow Laminar and turbulent flows, streamline, pathline and streakline Acceleration equations, continuity equations, circulation and vorticity, flownet
<b>Unit 4</b>	<b>Dynamics of Fluid Flow</b> Euler's equation of motion, application of Euler's equation Bernoulli's equation, applications of Bernoulli's equation, cavitation, momentum
<b>Unit 5</b>	<b>Navier-Stokes Equations of Motion</b> Navier-Stokes equations in cylindrical co-ordinates, boundary conditions Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries
<b>Unit 6</b>	<b>Analysis of Flow Through Pipes</b> Energy losses in pipe lines, minor losses in pipe lines due to enlargement, contraction, bends and pipe fitting Equivalent Length and Equivalent Pipes, Concept of equivalent length and equivalent pipes Problems in Pipe Flow, Determination of pipe diameter, determination of discharge, determination of head loss Other Systems for Flow, Hydraulic power transmission through a pipe, siphon, multiple pipe systems, water hammer
<b>Unit 7</b>	<b>Flow Measurements</b> Measurement of Flow in Pipes, Venturimeter, flow nozzle, sharp edged concentric orifice meter, bend meter, rotameter. Measurement of Velocity, Pitot tube, hot wire anemometer, current meter. Flow through Orifices, Determination of hydraulic coefficient of orifice, large orifice, standard orifice, mouthpieces or short tubes. Measurement of Flow in Open Channels. Weirs: triangular weir, trapezoidal weir, Cipolletti weir, submerged weir, broad crested weir; flow under sluice gate.
<b>Unit 8</b>	<b>Fluid Machines</b> Turbines and pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump. Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps. Submersible pumps: Reciprocating pumps: working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump.
<b>Practical</b>	<b>Title</b>
1	Study of different types of pipes, pipe fittings and tools
2	Study of different types of valves used in pipe lines

- 3 Plotting flow rate versus pressure drop with U-tube manometer
- 4 Verification of Bernoulli's theorem
- 5 Determination of discharge coefficient for Venturi
- 6 Determination of discharge coefficient for Orifice
- 7 Determination of discharge coefficient for V-Notch.
- 8 Determination of critical Reynold's number of laminar, transition and turbulent flow by Reynold's apparatus.
- 9 Calibration of Rota meter.
- 10 Determination of frictional coefficient of the pipe line
- 11 Determination of minor head losses in fluid flow
- 12 Study of reciprocating pump
- 13 Study of centrifugal pump and determination of performance characteristics
- 14 Study of submersible pumps
- 15 Study of gear pumps
- 16 Study of positive displacement pump

#### **Text books**

1. Fluid Mechanics by Jagdish Lal, Published by Metropolitan Book Co.
2. Fluid Mechanics, by Streeter V. L. and Wylie E. B. Published by McGraw Hill, SI Edition

#### **Reference books**

1. Hydraulics and Fluid Mechanics (SI Units), by Modi P. N. and Seth S. M. Published by Standard Book House
2. Fluid Mechanics. by Jain A. K., Published by Khanna Publication

**FPE 232                      3 (1+2)**  
**Engineering Drawing and Graphics                      (16 Lectures + 32 Practical)**

- Unit 1** Introduction of drawing scales; Principles of orthographic projections; References planes;
- Unit 2** Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines;
- Unit 3** Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids.
- Unit 4** First and third angle methods of projection. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique section. Sectional drawing of simple machine parts.
- Unit 5** Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components. Computer hardware for CAD.
- Unit 6** Geometric modeling techniques. Introduction to solid modeling.

**Practical**

- 1 Familiarization with drawing instruments and their uses
- 2 Study of different type of scales and related terminology
- 3 Construction of different scales
- 4 Study of useful terminology of projections
- 5 Problems on projection of points lying in different quadrant with respect to two reference planes
- 6 Problems on projection of straight line lying in different quadrant with respect to two reference planes
- 7 Study of useful terminology of different types of planes and their traces
- 8 Problems on projection of planes lying in different quadrant with respect to two reference planes
- 9 Study of useful terminology of different types of solids
- 10 Problems on projection of solids lying in different quadrant with respect to two reference planes
- 11 Study of useful terminology of section of solids
- 12 Problems on section of solids lying in different quadrant with respect to two reference planes
- 13 Problems on intersection of different solids with respect to two reference plane
- 14 Study of different methods of development and problem on development of surfaces of diff. solids
- 15 Study of useful terminology of isometric projection
- 16 Problems on isometric view . isometric projection of different solids with their diff. position with respect to two reference plane

**Reference Books**

1. Elementary Engineering Drawing , By: N.D. Bhatt ,
2. Engineering Drawing & Graphics , By: K. Venugopal
3. Engineering Drawing , By: D.N. Ghose
4. Geometrical Drawing , By: R. K. Dhawan,
5. Engineering Drawing , By: P. S. Gill

**FPE 233            3 (2+1)**  
**Food Process Engineering – I**

**(32 Lectures + 16 Practical)**

- Unit 1            Introduction to Food Process Engineering**  
 Method of studying food process engineering, basic principles of food process engineering, conservation of mass and energy, overall view of an engineering process, molecular transport of momentum, energy and mass, air water mixtures-Mollier's psychometric diagram.  
 Dimensions, symbols, units, dimensional consistency, unit consistency and unit conversion, dimensionless ratios, precision of measurement.
- Unit 2            Material and Energy Balance**  
 Material Balance: Basic principles, material balances, basis and units total mass and composition concentrations. Types of process situations, continuous processes, blending, layout.  
 Energy Balance: Energy balances, heat balances, enthalpy, latent heat, sensible heat, energy balance equation in drying, freezing and canning. Other forms of energy, mechanical energy, electrical energy.
- Unit 3            Heat – Transfer Theory**  
 Introduction: Heat Conduction, thermal conductance, thermal conductivity.  
 Conduction: Conduction through a slab, Fourier equation, heat conductances, heat conductances in series. Heat conductances in parallel, surface-heat transfer, heat transfer coefficients. Newton's law of cooling, unsteady-state heat transfer, Biot number, Fourier number, charts.  
 Convection: Convection-heat transfer, Nusselt number, Prandtl number, Grashof number. Natural convection, natural convection equations, vertical cylinders and planes, horizontal cylinders & horizontal planes. Forced convection, forced-convection equations, inside tubes, over plane surfaces, outside tubes, overall heat-transfer coefficients, heat transfer to boiling liquids.  
 Radiation: Radiation-heat transfer, Stefan-Boltzmann law, black body, grey body, emissivity, absorptivity, reflectivity. Radiation between two bodies, radiation to a small body from its surroundings.  
 Dielectric Heating: Microwave and RF heating, electromagnetic field, volumetric heat generation.
- Unit 4            Heat-Transfer Applications**  
 Thermal Processing: Thermal processing, thermal death time, F values, equivalent killing power at other temperatures, z value, sterilization, integration, time/temperature curves. In-can processing, thermal process calculations for canned foods, retorts, pasteurization, milk pasteurization, high temperature short time HTST process, UHT process.  
 Heat Exchangers: Types of heat exchangers, continuous-flow heat exchangers, parallel flow, counter flow, cross flow heat exchanger. Heat transfer in heat exchangers, log mean temperature difference (LMTD). Jacketed pans, heating coils immersed in liquids, Scraped surface heat exchangers, plate heat exchangers, shell and tube heat exchangers.
- Unit 5            Evaporation**  
 Evaporation Theory: Boiling point elevation, Raoult's law, Duhring's rule, Duhring plot, latent heats of vaporization. Evaporation of heat-sensitive materials, heat transfer in evaporators, vacuum evaporation.  
 Evaporation Equipment: Vacuum pans, horizontal-tube evaporators, vertical-tube evaporators, plate evaporators, long-tube evaporators, forced-circulation evaporators. Falling film and rising film heat exchangers agitated film equipment, single-effect evaporator, agitated thin film evaporators. Multiple-effects evaporation, feeding of multiple-effect evaporators, advantages of multiple-effect evaporators, vapour recompression, condensers.
- Unit 6            Drying**  
 Drying Theory: Heat transfer in drying, dryer efficiencies Mass transfer in drying,

mass transfer coefficient, drying rate curves, constant rate of drying, falling-rate of drying, calculation of drying times.

Classification and Selection of Dryers: Classification based on heat transfer by conduction, convection and radiation, criteria of dryer selection for foods.

Dryers: Tray dryers, tunnel dryers, trough dryers, bin dryers, belt dryers, roller or drum dryers. Vacuum dryers, osmotic dehydrators, fluidized bed dryers, spray dryers, pneumatic dryers, rotary dryers. Foam mat dryer, freeze dryers, moisture loss in freezers and chillers, microwave dryers, IR dryers, heat pump dryers.

## Unit 7

### Freezing

Food Freezing Theory: Frozen food properties: density, thermal conductivity enthalpy, apparent specific heat and thermal diffusivity. Plank's equation, shape factors, factors influencing freezing time, freezing rate and thawing time, freeze drying, spray freezing using liquid nitrogen.

Freezing and cooling Equipment/Systems: Indirect contact systems, plate freezers, air blast freezers, and freezers for liquid foods, direct contact systems, air blast immersion, principles of cooling for preservation, pre-storage requirements, pre-cooling, vacuum pre-cooling.

### Practical

#### Title

1. Practice on unit conversions problems and dimensional analysis in food processing
2. Problems on energy and mass balance
3. Heat transfer analysis during conduction and convection
4. Study of working principle and constructional details plate heat exchanger
5. Study of working principle and constructional details of shell and tube heat exchanger
6. Study of working principle open pan and vacuum evaporator
7. Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods
8. Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods
9. Study of operation and constructional details of vapour condensers
10. Study of hot air dryer and modelling drying kinetics
11. Study of vacuum dryer and modelling drying kinetics
12. Study of working principle of spray dryer and spray drying process
13. Study of microwave vacuum dryer and drying process
14. Study of drum dryer and liquid food dehydration using drum drying
15. Study of fluidized bed dryer and drying process
16. Study of freeze dryer and freeze drying process

### Text books

1. Unit Operations in Food Processing by R.L.Earle, Published by NZIFST (Inc.)
2. Fundamentals of Food Process Engineering by R.T.Toledo, Published by Springer
3. Engineering Heat transfer by Karlekar and Dashmond

### Reference Books

1. Food Processing Handbook, by J.G.Brennan, WILEY-VCH Verlag GmbH & Co. KGaA
2. Unit operations in Food Engineering by A. Ibarz and Gustavo V Barbosa-Canovas
3. Drying and Dehydration of Foods. Loesecke, Allied Scientific Publishers
4. Food Process Engineering and Technology by Zeki Berk, Published by ELSEVIER
4. Engineering Heat transfer by Gupta and Prakash,
5. Handbook of Industrial Drying by A.S. Mujumdar. Published by Taylor and Francis

**Env 231    2(1+1)**  
**Environmental Science**

**(16 Lectures + 16 Practical)**

**Unit 1    Introduction to Environment, Ecology and Ecosystem**

Definition and Inter-relationships amongst and between them Components of environment, Relationship between different components Man-Environment relationship Impact of Technology on the environment Environmental Degradation:

**Unit 2    Ecology & Ecosystems**

Introduction: Ecology- Objectives and Classification Concepts of an ecosystem- structure & function of ecosystem Components of ecosystem- Producers, Consumers, Decomposers Bio-Geo- Chemical Cycles- Hydrological Cycle, carbon cycle, Oxygen Cycle, Nitrogen Cycle, Sulfur Cycle Energy Flow in ecosystem, Food Chains: Grazing, Detritus, & Food webs, Ecological Pyramids, Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem.

**Unit 3    Population & Natural Resources**

Development of Habitation patterns and Environmental factors governing human settlement Population & Pollution , Reasons for overpopulation ,Population growth, Demographic Projections and Population Structures ,Production of food

**Unit 4    Renewable & Non-renewable Resources: Renewable Resources, Non-renewable**

Resources, Destruction versus Conservation Water Resources: Water Resources-Indian Scenario, Water Sources- Surface & Ground Water Sources, Uses & overuses of water resources, problems due to Overexploitation of Water Resources

**Unit 5    Forest Resources**

Forest Resources- Indian Scenario, Importance of forests- Ecologically & Economically, Uses of forest products, Forest Types, Deforestations-Causes and effects, Forest Degradation in India Energy Resources: Energy Resources - Indian Scenario, Conventional Energy Sources & its problems, non-conventional energy sources- Advantages & its limitations, Problems due to Overexploitation of Energy Resources.

**Unit 6    Environmental Pollution**

Types of Environmental Pollution: Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution, Classification of water pollutants, Effects of water pollutants, Eutrophication. Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like SPM, SO<sub>2</sub>, NO<sub>x</sub> – Natural & Anthropogenic Sources, Effects of common air pollutants.

Land & Noise Pollution: Introduction- Lithosphere, Land Uses, Causes of land Degradation, Sources of Noise Pollution, Effects of noise pollution Current Environmental Global Issues : Global Warming & Green Houses Effects, Acid Rain , Depletion of Ozone Layer

**Text Books**

1. Environmental Science by Richard T Wright & Bernard J Nebel
2. Environmental Engineering & Management by Suresh K Dameja
- 3 Introduction To Environmental Engineering and Science by Master Gilbert M.

**Reference Books**

- 1 Environmental Studies: R. Rajagopalan, Oxford University Press
- 2 Environmental Pollution: Causes, Effects & Control by K.C Agrawal
- 3 Environmental Science by Daniel B Botkin & Edward A Keller
- 4 Environmental Management by Dr. Swapan C Deb
- 5 Environment & Ecology by Dr Gourkrishna Dasmohapatra

**FPT 231            3 (2+1)**  
**Food Processing Technology - I**

**(32 Lectures + 16 Practical)**

**Unit 1      Introduction**

Food processing- historical development, status of food processing industry in India, Food processing policy of India, sources of food and their classification- plant foods, animal foods, sea foods. Mechanism and Techniques: Definition of preservation, scope, requirement and advantages of preservation, mechanism of food preservations. Techniques of food preservation- thermal/heat processing (microwave, dielectric), chilling, freezing, chemical, fermentation, irradiation.

**Unit 2      Thermal Processing**

Blanching- definition, advantages, equipment, effect of blanching on food nutrients, colour, texture and flavour. Pasteurization- definition, types, equipment, effect of pasteurization on food nutrients, colour, flavour and aroma. Sterilization- definition and type In container sterilization, ultra high temperature sterilization, effect of sterilization on food nutrients, colour, flavour and aroma, aseptic processing

**Unit 3      Cold Processing**

Chilling- Theory, systems for chilling, chill injury; Chill storage conditions for fruits and vegetables. Freezing- Theory, crystal formation, quick and slow freezing, cryogenic freezing, thawing, application of freezing in food

**Unit 4      Irradiation processing**

Irradiation- mechanism and effect on ionizing radiation on food. Type of irradiation, advantage and limitations of irradiation. Food irradiation equipment, processing of spices, onion and potatoes using irradiation

**Unit 5      Extrusion Processing**

Extrusion- theory and advantages, rheological properties of the food and operating characteristics for extrusion. Equipment- single-screw extruders and twin-screw extruders, Applications of extrusion - cold extrusion and extrusion cooking, effect on foods-sensory characteristics and nutritional value, Extruded products- expanded snack products, pasta products, texturised vegetable protein

**Unit 6      Baking and Roasting**

Definition, food application- (Bread, biscuit, cakes), baking equipment, effect of baking and roasting on food nutrients, colour, flavour and aroma

**Practical      Title**

1. Determination of adequacy of blanching of vegetables.
2. Study the effect of blanching on nutritive quality
3. Study the effect of blanching on colour of the food product
4. Bottling of peas and to study the effect of heat processing
5. Determination of adequacy of pasteurisation/sterilization
6. Study the effect of pasteurisation/sterilization on nutritive quality
7. Study the effect of pasteurization/sterilization on colour of the food product
8. Study the freezing and thawing behaviour of the food product
9. Visit to irradiation processing unit
10. Study the effect moisture content of raw material on extruded food product
11. Study the effect of machine parameter on extruded food product
13. Study of various textural quality characteristics of the extruded products
13. Development of cold extruded food products
14. Study of the effect of baking on nutritive quality of the food
15. Study of textural and sensory characteristics of baked product
16. Visit to food processing technology industry

**Text books**

1. Principles of Food Science: Part-II Physical Principles of Food Preservation. Edited by O.R. Fennema Publisher-Marcel Dekker, New York.
2. Food Processing Technology: Principles and Practice. P. Fellows (Second Edition). Publisher-Woodhead Publishing Limited and CRC Press LLC.

**Reference books**

1. Fruit and Vegetable Preservation: Principles and Practices by RP Srivastava and S Kumar, (Second Edition), Publisher-International Book Distributing Co. Lucknow.
2. Food Science, (5<sup>th</sup> Edition) by N N Potter, and JH Hotchkiss, Aspen Publishers, Inc., Gaithersburg, Maryland.
3. Managing Frozen Foods edited by Christopher J. Kennedy, Woodhead Publishing Limited, Abington, Cambridge, England

**PHE 231      4 (3+1)**  
**Post Harvest Engineering**

**(48 lectures + 16 Practicals)**

<b>Unit 1</b>	<b>Introduction</b> Post harvest technology of crops: An over view of concept and science, production and post harvest losses, reasons for losses, importance of loss reduction, role in export, economy, and employment generation.
<b>Unit 2</b>	<b>Decorticating &amp; shelling</b> Principles of working, design and constructional details, operating parameters, maintenance etc of various decorticators /dehullers /shellers, description of groundnut decorticators, maize shellers etc
<b>Unit 3</b>	<b>Psychometry</b> Psychometry, absolute humidity, relative humidity, dry bulb temperature, wet bulb temperature, dew point temperature, wet bulb depression, humid heat, specific volume, Lewis number, psychometric charts, equilibrium moisture content, heating, cooling, dehumidifying, sorption isotherms, three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, equilibrium moisture content, (hysteresis, measurement of humidity, hygrometers
<b>Unit 4</b>	<b>Field drying</b> Basic drying theory, types of drying (deep bed and thin layer drying, superheated steam drying, IR, RF and MW drying etc), types of dryers (flat bed dryer, continuous flow dryer, recirculating dryer, LSU dryer, rotary dryer, RF dryer, fluidised bed dryer, sprouted bed dryer, tray dryer, tunnel dryer), dryer performance, energy requirement in drying
<b>Unit 5</b>	<b>Parboiling</b> Parboiling, changes during parboiling, advantages and disadvantages of parboiling, Traditional parboiling methods, modern parboiling methods, significance of glass transition temperature
<b>Unit 6</b>	<b>Cleaning</b> Cleaning of grains, fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance
<b>Unit 7</b>	<b>Sorting and Grading</b> Sorting, grading, methods of grading, grading- size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance.
<b>Unit 8</b>	<b>Separation</b> Magnetic separator, destoners, electrostatic separators, pneumatic separator
<b>Unit 9</b>	<b>Milling</b> Milling, polishing, grinding, milling equipments, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement
<b>Unit 10</b>	<b>Conveying</b> Introduction to different conveying equipments used for handling of grains, fruits and vegetables
<b>Unit 11</b>	<b>Storage</b> Introduction to storage structures, bins, silos, bag and bulk storage
<b>Practical</b>	<b>Title</b> 1 Study of decorticators, principles and working 2 Study of a maize/sunflower sheller 3 To determine state of air using psychometric chart and hygrometer 4 Use of psychometric chart during drying process/ humidification process 5 Study of crop dryers, batch and continuous & LSU dryers

- 6 Study of a RF/MW/Fluidised bed/tray dryer
- 7 Study of cleaners for grains
- 8 Study of washers for fruits and vegetables
- 9 Study of graders for grains, grading efficiency
- 10 Study of graders for fruits and vegetables, grading efficiency
- 11 Study of rice milling machines
- 12 Study of pulse milling machines.
- 13 Study of different components of Flour mill.
- 14 Study of oil expeller.
- 15 Visits to rice mills, pulse mills, oil mills

### **Text Books**

1. Post harvest technology of cereals, pulses and oilseeds, Oxford Publishing by A. Chakraverty
2. Principles & Practices of Post Harvest Technology, Kalyani Publishers by P. H. Pandey.
3. Principles of Agricultural Engineering, Volume – I, Jain Brothers by A. M. Michael & T. P. Ojha

### **Reference books**

1. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed, Prentice Hall Ptr by Christie J. Geankoplis & Pamela R. Toliver.
2. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices, Marcel Dekker, Inc., NY, CRC press by A. Chakraverty, and others.
3. Unit Operations in Chemical Engineering, 7<sup>th</sup> Ed, McGraw-Hill Professional by Mc Cabe, Smith & Harriott.
4. Rice: Chemistry and Technology, 3<sup>rd</sup> Ed, 2004, AACC by Elaine T. Champagne.
5. Wheat: Chemistry and Technology, 4<sup>th</sup> Ed, AACC by Khalil Khan & Peter R. Shewry.
6. Corn: Chemistry and Technology, 2<sup>nd</sup> Ed., AACC by Pamela J. White & Lawrence A. Johnson.