

**Syllabus of 3<sup>rd</sup> Year B. Tech. Food  
Technology  
w.e.f. 2016-17**

<b>B. Tech. 3<sup>rd</sup> Year (Food Technology) Revised Syllabus w.e.f. 2016-17</b>							
<b>Course Code</b>	<b>Title of Course</b>	<b>Teaching Hours</b>	<b>Tutorial</b>	<b>Credits</b>	<b>Practical Hours</b>	<b>Credits</b>	<b>Total Credits</b>
<b>Fifth Sem.</b>							
CHL308	Mass Transfer Operations	04		04			4.0
CHP 309	Mass & Momentum Transfer Operations				03	1.5	1.5
CHC-310	Instrumentation and Process Control	04		04	03	1.5	5.5
FTC-301	Principles of Food Preservation	04		04	03	1.5	5.5
FTL-302	Microbiology and Molecular Biology	04		04	-	-	04
FTP-303	Microbiology and Molecular Biology	-		-	05	2.5	2.5
ELECTIVE	Elective-I	04		04	-	-	4
<b>Total</b>		<b>20</b>		<b>20</b>	<b>14</b>	<b>7.0</b>	<b>27.0</b>
<b>Sixth Sem</b>							
CHL-311	Reaction Engineering	04		04	-	-	4
HML-301	Industrial Management & Economics	03		03	-	-	03
HML-302	Managerial Behaviour: Psycho-social Dimensions	03		03	-	-	03
FTC-304	Food Processing-I	04		04	03	1.5	5.5
FTC-305	Food Biotechnology	04		04	03	1.5	5.5
ELECTIVE	Elective - II	04		04	-	-	04

<b>Total</b>		<b>22</b>		<b>22</b>	<b>06</b>	<b>3.0</b>	<b>25</b>
	<b>Seventh Sem</b>						

## FIFTH SEMESTER

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: CHL-308</b>
<b>Course Title</b>	<b>: Mass Transfer Operations. (TH)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### Course Objective:

At the end of the course student will understand the basic fundamental of mass transfer operations carried out in chemical industries, design of plate and packed column used for mass transfer operations, Distillation, Liquid-liquid extraction, Solid-liquid operation, Crystallization and Adsorptiondrying operation.

### Course Content:

#### Unit-I

##### Diffusion

Principles of diffusion, Fick's law, diffusion in binary mixture, equimolecular counter diffusion, mass transfer through stationary gas, mass transfer velocities, gas phase mass transfer cases, thermal diffusion, Maxwell law, diffusion in solids, Diffusion in liquids: Mass transfer across phase boundary, penetration theory, two film theory, surface renewal theories, film-penetration theory of mass transfer, mass transfer coefficients & correlation,

#### Unit-II

##### Distillation

Distillation methods, Vapour liquid equilibria, ideal and non-ideal systems, relative volatility, partial vaporisation/condensation, calculation of number of theoretical plates by McCabe Thiele method. Importance of reflux ratio, minimum reflux ratio, optimum reflux ratio. Murphree plate efficiency and overall plate efficiency. Effect of feed condition of 'q' line.

### **Unit-III**

#### **Absorption**

Mechanism of absorption, choice of solvent for absorption, rate of absorption & material balance over absorption tower, minimum gas-liquid ratio for absorber, The absorption with & without chemical reaction,

**Packed towers:** General construction & working, types of packing merits & demerits, operational difficulties, pressure drop & limiting gas-liquid flow rates, Determination of height of columns, transfer units, capacity.

**Plate towers:** General construction & working, types of plates merits & demerits, operational difficulties

### **Unit-IV**

#### **Extraction**

Liquid-Liquid Extraction: Principle, selection of solvent for extraction, estimation of mass transfer coefficients, triangular diagram representation, Equipment for liquid-liquid extraction. (Mixer settler, Rotating Disc Contractor, Packed column, spray column). Single stage extraction calculation.

**Adsorption:** Fundamentals, adsorbent, adsorption equilibria and isotherms.

### **Unit-V**

#### **Drying:**

Drying characteristics of material, theory and mechanism of drying, Performance of batch and continuous dryer, time of drying.

#### **Crystallization**

Crystallization:- Principle, Super saturation, methods of achieving super saturation, phenomenon of crystal formation, crystal structure, material & heat balance over crystalliser & related problems

**References:**

1. Treybal R.E. "Mass Transfer Operations" McGraw Hill Book Co., New York 1980
2. McCabe W.L. and Smith J.C. & Harriot, "Unit Operations of Chemical Engineering", McGraw Hill Book Co., New York 1980
3. Principles of Unit Operations: Foust A.S.
4. Coulson J.M. and Richardson J.F., "Chemical Engineering Vol. I, II & III", Pergamon Press, New York 1977
5. Unit Operation: Mc Cetta Vol. I
6. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill Book Co.
7. Chattopadyay P., "Unit Operations of Chemical Engineering", Vol. 1 & 2, Khanna Publishers, New Delhi.

**Course Outcomes:**

1. Students will learn about the fundamentals of diffusional mass transfer in solids and fluids.
2. Student will understand the application of mass transfer theories in various unit operations.
3. Student will understand the mechanism and operation of absorption/stripping column.
4. Student will understand the design of binary plate and packed distillation column.
5. Student will understand the design liquid-liquid and solid-liquid extraction column.
6. Student will understand the design crystallization and adsorption column.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: CHP -309</b>
<b>Course Title</b>	<b>: Mass and Momentum Transfer Operation (PR)</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 1.5</b>

### **Course Content:**

(Minimum 10 experiments)

1. Determination of vapour diffusivity
2. Study of Liquid –liquid diffusion through porous pot.
3. Batch/Tray drying.
4. Wetted wall column.
5. To verify Rayleigh's equation,
6. To study boiling point diagram/ vapour-liquid equilibria.
7. To study distribution coefficient in liquid-liquid. Extraction.
8. To Construct bimodal curve for ternary system.
9. Laboratory Batch Crystallisation,
10. To Study Bernoulli's theorem
11. To calculate coefficient of discharge of Venturimeter, orifice meter.
12. To study the type of flow using Reynold's experiment.
13. To calculate various losses through pipe fittings
14. To calculate coefficient of discharge through triangular/trapezoidal/rectangular notches.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: CHC 310</b>
<b>Course Title</b>	<b>: Instrumentation and Process Control</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### **Objective-**

To study the different Instruments like temperature , pressure, level and flow measuring instruments and their working and applications. The utilization of chemical process control and dynamics in automatic , advanced chemical process and study of response of various forcing functions for first, second and higher order control system and study of various types of control mechanism for optimize control of chemical process and their stability

### **Course Content:**

#### **Unit- I**

**(10hrs)**

**Measuring instruments:** Elements of measuring instruments, Static and dynamic characteristics of measuring instruments

**Temperature measurement:** Temperature scales, Thermocouples, bimetallic thermometer, resistance thermometer, vapour pressure thermometer, mercury in glass thermometer, constant volume gas thermometer, radiation and optical pyrometers.

**Pressure measurement:** Manometers, Elastic pressure transducers: Bourdon tube, diaphragm, and bellows; Electrical pressure transducer.

#### **Unit -II**

**(10 hrs)**

**Level measurement:** Direct and indirect methods, float type, bubbler systems, air purgemethod.

**Laplace transform:** Inversion by Partial Fractions, first order control system, Mercury thermometer, development of transfer function and response, forcing functions- step, impulse, ramp, sinusoidal and their responses.

**Unit -III****(10 hrs)**

Physical examples of first order systems – Liquid level and mixing process, Interacting and non interacting systems and their transient response and numericals based on theory.

**Unit -IV****(10 hrs)**

Second order control systems- transfer function of damped vibrator and U-tube manometer and development of step response equations for underdamped overdamped and critical damped system.

**Unit-V****(10 hrs)**

Linear closed loop system, simple control system negative feedback vs. positive feedback, Servo problems, regulator problem, development of Block diagrams representing transfer functions.

Pneumatic and electronic controllers and final control elements, choice of controllers, On off, Proportional, PI, PID & PD.

**References:**

1. Process Systems Analysis and Control: Donald R. Coughanowr
2. Industrial Instrumentation: Eckman
3. Process Control and Instrumentation: R.P. Vyas

**Outcomes-**

1. Students will able to know the construction, working, application and advantages and disadvantages of temperature, pressure, level and flow measuring instruments.
2. From the course the students will able to know the complete dynamics of the chemical process and understand the different kinds of forcing function and responses.
3. The student will understand the method for obtaining the transfer function, response equation and physical behavior of first, second and higher order control system.
4. Students understand feedback control system and various types of control actions like ON OFF, P, PI, PD, PID and their applications and usefulness in the different chemical process and Industries.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: CHC 310</b>
<b>Course Title</b>	<b>: Instrumentation and Process Control</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 1.5</b>

**Objective:**

To study the basic controls systems through the experiments of first order and second order control systems. How the systems responds to change in inputs.

**Course Content:**

1. To study the Dynamic study of mercury thermometer and determine time constant
2. To study step response in Single tank liquid level system
3. To Study the liquid level two tank Non-interacting systems
4. To Study the liquid level two tank Interacting systems
5. To Study the control system of mixing Process and to determine time constant
6. To study linear and equal control valve characteristics
7. To study the dynamic response of second order system (U-Tube manometer etc.)
8. To study response of mercury thermometer and bimetallic thermometer
9. To determine the time constant and damping coefficient of second order system (U-Tube manometer etc.)
10. To study impulse response in Single tank liquid level system

**Outcomes:**

Students comes to know by performing various practicals, how the basic control systems and instruments are applicable in chemical process industries.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-301</b>
<b>Course Title</b>	<b>: Principles of Food Preservation</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

**Course Pre-requisite:**

To learn the basic knowledge of principles of food preservation, requires pre-knowledge of Food chemistry (FTC-201), Food Biochemistry and nutrition (FTC-202) and mass transfer operations (CHL-308).

**Course Objectives:**

1. To study various factors responsible for food spoilage.
2. To study various thermal food processing technology for food preservation.
3. To study about various chemical preservatives to increase shelf life.
4. To study drying and dehydration techniques
5. To study effect of low temperature for food processing.

**Course Content:**

**Unit –I** **(10 hrs)**

**Food Spoilage:** Role of physical, chemical, biological and microbiological factors in food spoilage. Intrinsic and Extrinsic factors affecting food spoilage. Basic principles and methods of food preservation

Preservation by Chemicals: Role of chemicals in Food preservation. Class I and Class II preservatives and their role in various foods.

**Unit-II** **(10 hrs)**

**Thermal processing of Foods:** Cooking, Blanching, Pasteurization, Sterilization. Factors affecting heat penetration, Process time calculation using z and F value, Unit operation in canning, aseptic processing.

### **Unit – III**

**(10 hrs)**

**Dehydration:** Role of water activity in food preservation. Method of dehydration. Unit operation in drying. Cabinet dryers, Vacuum dryer, fluidized bed dryer, Spray dryer, Drum dryer, Solar and Microwave dryers. Osmo-air dehydration.

### **Unit-IV**

**(10 hrs)**

**Concentration:** Principle of concentration, Types of concentrators, open pan vacuum and freeze concentration, membrane concentration,

**Irradiation:** Sources of Irradiation, methods and doses of irradiation. Effect of irradiation on quality of foods.

### **Unit-V**

**(10 hrs)**

**Low Temperature preservation of foods:** Unit operation in Freezing , Cold Storage, Chilling, Freezing of foods, Types of freezers, Storage and transportation of Frozen foods.

### **Book Reference**

#### **Text Books**

1. Food Microbiology by W. C. Frazier, Tata McGraw Hill Publishing Co.
2. The Fundamental of Food Engg. By Charm S. E., The AVI Publishing co. Inc. Westport Connctiout 1963.
3. Principles of Food Preservation Part II By Owens R. Fenemma.
4. Technology of Food Preservation : By Desrosier Norman W. AVI Publishing Co. Inc. London.
5. The Freezing Preservation of Foods Vol. 1,2,3 & 4 edited by Eople M. J. & Co. Inc. Westport Conncticut 1964.
6. Radiation Technology by Desrosier, N.W. AVI Publishing Co. Inc, 1960.
7. Modern Technology on Food Preservation : NIIR BOARD : Asia Pacific Business Press Inc.

#### **Course Outcomes:**

1. Student learnt, causes of food spoilage (physical, chemical and biological cause) and principles of their control
2. Students acquired knowledge of thermal processing of Foods (canning, aseptic, pasteurization, blanching)
3. Student learnt techniques of food preservation such as chemical preservation, dehydration, concentration, low temperature and irradiation.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-301</b>
<b>Course Title</b>	<b>: Principles of Food Preservation</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 1.5</b>

**Course Pre-requisite:**

To learn the practical knowledge of principles of food preservation, requires pre-knowledge of Food chemistry (FTC-201), Food Biochemistry and nutrition (FTC-202) and mass transfer operations (CHL-308).

**Course Objectives:**

1. To study various factors responsible for food spoilage.
2. To study various thermal processing techniques for food preservation.
3. To study about various chemical preservatives to increase shelf life.
4. To study drying and dehydration techniques
5. To study effect of low temperature for food processing.

**Course Content:**

Demonstration of food processing equipments

To study the adequacy of blanching treatment of fruits and vegetables

Bottling and canning of foods

Preservation of fruits squash by chemical preservation

Concentration of fruits juices

Dehydration of fruits and vegetables

To study the effect of low temperature on quality of fruits (Chilling injury)

Cutout analysis of Canned fruits.

**Books recommended:**

1. Chemical analysis of food and food product by Pearson D, J.E.A Churchill, 104, Gloucester place, London sixth edition 1970.
2. Manual of analysis of fruit and vegetable products by Ranganna s

3. Official method of analysis of association of official analytical chemists P. B No 540 Benajarin Franklin station Washington D C , 20044, 1970.
4. Preservation of fruits and vegetables by Giridharilal & Sidappa, ICAR Publication

**Course Outcomes:**

1. Students will be able to learn techniques of food preservation, such as dehydration, concentration, low temperature and chemicals
2. Student will be able to learn thermal processing of Foods (canning, pasteurization, blanching)

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTL-302</b>
<b>Course Title</b>	<b>: Microbiology and Molecular Biology</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### **Course Pre-requisite:**

To learn the basic knowledge of microbiology and molecular biology, requires pre-knowledge of Food chemistry (FTC-201), Food Biochemistry and nutrition (FTC-202)

### **Course Objectives:**

1. To study Historical background of microbiology, classification and terminology of microorganism,
2. To study morphology and physiology of bacteria, yeast, molds and actinomycetes, introduction to viruses, occurrence of viruses in food.
3. To study composition of nutrient media growth, reproduction, isolation and characterization of microorganism.
4. To study various techniques of controlling micro organisms.
5. To study mycotoxins, spoilage of fresh and processed foods.

### **Course Content:**

#### **Unit- I**

**(10 hrs)**

Historical background of microbiology, classification and terminology of microorganism, study of morphology and physiology of bacteria, yeast, molds. Introduction to viruses, occurrence of viruses in foods, Scope and importance of food microbiology

#### **Unit - II**

**(10 hrs)**

Nutritional requirement of micro-organism. Autotrophic and heterotrophic mode of nutrition, composition of nutrient media. Growth, reproduction, isolation and characterization of microorganism.

**Unit- III****(10 hrs)**

Enumeration of microorganism, effect of temperature on growth of micro-organisms, control of microorganism by high and low temperatures, determination of TDT curve, effect of dehydration, irradiation and chemicals on growth of microorganism. Evaluation of antimicrobial agents, control of microorganisms by physical and chemical methods.

**Unit- IV****(10 hrs)**

Maintenance and preservation of industrially important microbial cultures. Importance of microorganism in food industry, Food mycotoxins affecting human nutrition and health, sources, toxicity, symptoms, preservation, methods of detection and detoxification.

**Unit-V****(10 hrs)**

Contamination: Source of contamination and spoilage of fresh and processed food products. Spoilage of Canned foods, Bakery and confectionary products, milk and milk products, meat and meat products. Prevention of food spoilage.

**Reference Books:**

1. Food Processing Operation By M.A. Joslyn and J.L.Held, The AVI publishing co. Inc. Westport.
2. The Microbiological Safety of Food Edited by B. C. Hobs. J. H. E. Christian(1972), Academic Press.
3. Principles of Food Science: Vol II By G. Bergstrom, The MacMillan Co. Ltd, London.
4. Technology of Food Preservation : By Desrosier Norman W. AVI Publishing Co. Inc. London.
5. Microbiology : Prescott.Harley.Klein
6. Microbiology : Michael J.Pelczar, JR.
7. Food Microbiology by W. C. Frazier, Tata McGraw Hill Publishing Co.
8. Introductory Microbiology : Heritage, Evan & Killington

**Course Outcomes:**

1. Students are able to learn basics of food microbiology and micro organism and media for their growth, isolation and characterization.
2. Student learnt various techniques of control of micro-organisms by use of temperature, irradiation, chemicals etc.
3. Students learnt the intoxication by various mycotoxins and their control.
4. Students learnt the contamination and spoilage of f fresh and processed foods.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTP- 303</b>
<b>Course Title</b>	<b>: Microbiology and Molecular Biology</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 05</b>
<b>Course credit</b>	<b>: 2.5</b>

**Course Pre-requisite:**

To learn the practical knowledge of microbiology and molecular biology there requires pre-knowledge of Food chemistry (FTC-201), Food Biochemistry and nutrition (FTC-202).

**Course Objectives:**

1. To study composition of nutrient media growth, reproduction, isolation and characterization of microorganism.
2. To study enumeration of micro organisms.
3. To study isolation techniques.
4. To study the microbial quality of water.
5. To microbiological examination of various fresh and processed foods.

**Course Content:**

Methods of sampling

Preparation of dilution

CFU, yeast and molds count

Staining Techniques: Streak Plate, Pour Plate, Spread Plate

Enumeration of E-coli and pathogens

Measurement of activity of antimicrobial agents.

Microbiological examination of specific foods: Meat and meat products, Fruit and Vegetable,

Milk and milk products

Microbiological examination of water

**Course Outcomes:**

1. Students learnt the staining techniques for observing micro organisms .
2. Students learnt various isolation techniques of micro organisms.
3. Students learnt enumeration techniques of micro organisms.
4. Students learnt testing of the drinking water for presence of e-coli.
5. Students will be able to examine microbiological quality of various fresh and processed foods

**Choose any one subject from following two-Electives**

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: Elective-I, FTL-306</b>
<b>Course Title</b>	<b>: Advanced Technology in Food Packaging (Elective-I)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

**Course Pre-requisite:**

To learn the basic knowledge of Advanced Technologies in Food Packaging, requires pre-knowledge of Material technology (ESL-202), organic chemistry (BSC-102) and inorganic chemistry (BSC-104).

**Course Objectives:**

1. To study basic packaging materials and their types and functions .
2. To study various packaging systems used for food products.
3. Estimation of shelf life of packaged products.
4. To acquire knowledge of recent trends in food packaging.
5. To acquire knowledge of sealing and lamination techniques.

**Course Objectives:**

**Unit -I** **(10 hrs)**

Principle of food packaging, types and functions of packaging materials, filling and sealing of metallic, glass and plastic containers.

**Unit- II** **(10 hrs)**

Flexible packaging laminated packaging and retortable pouches, concept and determination of ERH, calculation of shelf life and requirement for packaging. Testing of packaging materials.

**Unit- III** **(10 hrs)**

Active packaging system: - Packaging requirement for different moisture level food products, Aseptic packaging of fruits & veg. milk and milk products, high barrier plastic

**Unit- IV****(10 hrs)**

Product- Package compatibility: - Packaging of microwavable food, MAP of fresh fruit and veg. vacuum and MAP of meat and meat products. Packaging of breakfast cereals, bakery and confectionary products

**Unit -V****(10 hrs)**

Packaging requirement for soft drink, alcoholic beverages, distilled spirits fermented food, frozen food, future trends in food packaging.

**Books Recommended:**

1. Handbook of food packaging edited by F. A Paine and H.Y paine.
2. Modern processing and distribution system for food edited by F. A Paine.
3. Chemical engg. Thermodynamics by Daubert.
4. Chemistry of Food Packaging by Swalam C.M., American Chemical Society, Washington D. C. 1974.
5. Packaging by Neubaner R.G. Van Nostrand Co. New York.
6. Food Packaging Principles and Practice : Gordon L. Robertson

**Course Outcomes:**

Students learnt following regarding the food packaging:

1. Students learnt basics of food packaging materials, systems and packaging types and functions.
2. Students learnt Flexible packaging, Active packaging system, Aseptic packaging, MAP (fruits and vegetables, meat and poultry),vacuum packaging, smart packaging and sensors for various food products.
3. Students learnt estimation of Shelf life of packaged products
4. Students learnt Packaging of microwavable food, soft drink, alcoholic beverages, frozen food.
5. Students are able to learn sealing and lamination techniques.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: Elective-I, FTL-307</b>
<b>Course Title</b>	<b>: Cereals and pulses processing technology (Elective-I)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

**Course Pre-requisite:**

To learn the basic knowledge of Advanced Technologies in Food Packaging, requires pre-knowledge of Material technology (ESL-202) and Food processing-I (FTC 304)

**Course Objectives:**

1. To study milling technology for rice, its byproducts and chemistry of rice
2. To study milling technology of wheat ,its byproducts and chemistry of wheat
3. To study milling technology of cornt ,its byproducts, and value added products from byproducts.
4. To study milling technology of pulses ,its byproducts,nutritional aspects and anti-nutritional factors
5. To study advanced milling technology of pulses ,its byproducts,,extruded products,puffing of pulses and quick cooking *Dal*

**Course Objectives:**

**Unit- I**

**(10 hrs)**

Introduction to rice as cereals, structure and chemical composition, drying and storage, rice milling process, factors affecting yield of rice during milling. Para-boiling of rice, aging and curing, byproduct of rice milling

**Unit –II**

**(10 hrs)**

Introduction to wheat as cereals, structure and chemical composition, drying and storage, wheat milling process, Milled product and their utilization, Indian standards for wheat and wheat products

**Unit- III****(10 hrs)**

Introduction to corn as cereals, structure and chemical composition, drying and storage, corn milling process, starch isolation from corn, value added products from corn byproduct of corn milling industry

**Unit- IV****(10 hrs)**

Introduction to pulses, structure, nutritional aspect, types of pulses, antinutritional factors, Milling characteristics of pulses, Unit operation in pulse processing,

**Unit -V****(10 hrs)**

Modern technology of milling of pulses. Extruded products from pulses. Quick cooking *Dals*, Puffing of pulses, byproducts of pulses processing technology

**Books Recommended:**

1. Technology of Cereals- Kent
2. Post Harvest Technology of Cereals, legumes and Oilseeds- Chakrawarthy
3. Post harvest Biotechnology of Legumes-Salunkhe DK and Kadam SS
4. Post Harvest Biotechnology of Oilseeds - Salunkhe DK and Kadam SS

**Course Outcomes:**

1. Students were able to learn milling technology of rice, its byproducts and chemistry of rice
2. Students were able to learn of milling technology of wheat ,its byproducts and chemistry of wheat
3. Students were able to learn milling technology of cornt ,its byproducts, and value added products.
4. Students were able to learn milling technology of pulses, byproducts,, nutritional and anti-nutritional aspects
5. Students were able to learn advanced milling technology of pulses , byproducts,, extruded products,.

## SIXTH SEMESTER

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: CHL-311</b>
<b>Course Title</b>	<b>: Reaction Engineering</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### **Objective:**

At the end of the course student will understand the basic fundamental of reaction engineering, design and performance of batch, CSTR and plug flow reactor, methods of analysis of reactor data to solve the problem aroused in chemical industry.

### **Course Objectives:**

#### **Unit –I**

**(10 hrs)**

Kinetics: Rate of reaction, types of reactions, Variables affecting the rate of reaction, order and molecularity, Temperature and concentration dependency of rate equation, theories of temperature dependency- Arrhenius theory, Bimolecular theory and Transition state theory, comparison between various theories of temperature dependancy of rate equation.

#### **Unit –II**

**(10 hrs)**

Interpretation of kinetic data in batch and flow systems, integral and differential methods of analysis, kinetics of unimolecular, bimolecular reactions, series, parallel, reversible, autocatalytic reactions, constant volume batch reactor, variable volume batch reactor. Rate equation.

#### **Unit –III**

**(10 hrs)**

Introduction to reactor design. Single ideal reactors: Ideal batch reactor, space time and space velocity, steady state mixed flow reactor, steady state plug flow reactor. Holding time & space time for flow systems. Comparison between mixed and plug flow reactor advantages and limitation in application.

#### **Unit –IV**

**(10 hrs)**

Plug flow reactors in series and or in parallel, equal size mixed reactors in series, mixed flow reactors of different sizes in series. Reactors of different types in series, recycle reactor, autocatalytic reactions. Principles of reactor stability and optimization. Residence time

distribution: Residence time function and relation amongst their application to ideal reactors.

## **Unit –V**

**(10 hrs)**

Catalysis:

Concept of catalyst selection, classification and characteristics of catalyst, preparation of a catalyst and its deactivation, poisoning of catalyst and regeneration. Different types of isotherms, determination of catalyst surface area By BET method.

Solid-catalyzed reaction:

Rate equations, diffusion within porous catalyst, experimental methods for finding rates, product distribution in multiple reactions.

### **Reference Books:**

1. Chemical Reaction Engineering, Wiley Eastern : O. Levenspiel
2. Chemical Reaction Engineering. : Fogler
3. Chemical Reaction Engineering. : S. D. Dawande
4. Chemical Reaction Kinetics. : J.M. Smith

### **Course Outcome:**

1. To enhance the ability of students to understand the classification of reactions, effects of various parameters on rate of reactions with different reaction rate theories.
2. To get the students well acquainted with collection and analysis of rate data using integral, differential, half-life method of analysis of rate data. To understand the kinetics of fast reactions.
3. To enhance the knowledge of students about ideal reactors, autocatalytic reactor, various parameters affecting the reactor performance, combine reaction system and comparison of various reactors.
4. The get the students well acquainted with thermal characteristics of reactors, residence time distribution, catalysis and modeling of real systems.
5. To enhance the ability of students to identify and solve various engineering problems during product optimization.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: HML-301</b>
<b>Course Title</b>	<b>: Industrial Management and Economics</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 03</b>

## **Objective**

Upon successful completion of this course the student will be able to:

1. Identification and selection of management & administration with aspect towards the Production planning and management Quality control and maintenance. Processes/operations according to job requirement in various departments.
2. Identification, selection and understanding of Financial Management capital structure Sources of Industrial finance including institutional feature inside the organisation as well as outside the organisation.
3. Understanding Cost Analysis Cost statement and sheet Cost control and various type of approach of the Industrial relation Quality management techniques Entrepreneurship Development Management information
4. Identification, understanding Micro and Macro economics Demand and Supply factors of market economy Functions of money w.r.t. organization.

## **Course Objectives:**

### **Unit-I**

Introduction meaning management & administration Functions of Management Planning and ,Organizing staffing c monitoring and leading co-ordinating & communication tool Functional of management Production Material Finance personnel Marketing Management concept of productivity wages .Production planning and management Quality control and maintenance.

### **Unit-II**

Types of management Different approaches of management Functional areas of management Forms of business organization production management work study productivity measurement

material management Inventory analysis Financial Management capital structure Sources of Industrial finance including institutional feature.

### **Unit-III**

Marketing management consumer satisfaction sales and advertising Marketing Research personnel management Industrial relation Quality management techniques Entrepreneurship Development Management information system Information technology In Management Cost Analysis Cost statement and sheet Cost control , Cost projection.

### **Unit-IV**

Nature and significance of Economics Basic problem in Economics Introduction of Micro and Macro economics Demand and Supply factors of market economy Functions of money Banking types and Functions

### **Unit-V**

Indian Economy Liberalisation privatisation and Globalisation Mixed Economy Public Sector Reforms National income determinants Economic planning nature and Entrepreneurship small scale Industries and SSI.

### **References:**

- 1) Modern Economics by H.L.Ahuja.
- 2) Modern economics theory by K.K.Dewett.
- 3) Monetary economics by M.L.Seth.
- 4) Industrial Management by I.K. Chopde, A.M. Sheikh.
- 5). Business Organisation and Management by S.A. Sherlekar.
- 6) Marketing Management by Philip Kotler

### **Outcomes:**

Upon successful completion of this course the student will be able to:

1. Identification and selection of management & production management work study productivity with aspect towards the material management & Inventory analysis Production planning Quality control and maintenance. Processes/operations according to job requirement in various departments in organisation.

2. Identification, selection and understanding the meaning and utility of Marketing management, consumer satisfaction, sales and advertising Marketing Research personnel management features of the organisation.
3. Understand the importance of Cost Analysis Cost statement and sheet Cost control and various type of approach of the Industrial relation Quality management techniques Entrepreneurship Development Management information system
4. Identification, understanding Micro and Macro economics Demand and Supply factors of market economy National income determinants Economic planning nature and Entrepreneurship Functions of money w.r.t. Organization
5. Identification, selection and understanding according to requirement in Different organization Financial Management, capital structure Sources of Industrial finance including institutional feature. Understanding of the working principle of Entrepreneurship Development and S.S.I.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: HML-302</b>
<b>Course Title</b>	<b>: Managerial Behavior and Psychosocial Dimension (TH)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 03</b>

### **Course Objectives:**

This subject aims at developing students with the required commitment and competencies for working towards the objectives within an organizational framework in order to improve both individual and organizational performance.

### **Unit -I**

Psychosocial dimension of work in organisation Introduction and background

### **Unit -II**

Approaches in Organisational analysis Organisational behaviour approach

### **Unit-III**

Early practises in Management Theories of Organisation Organisational process and Function  
The structural variables context. Environment of work organisation Socio-cultural Environment  
Its impact on Organisation Social dimension of organisational and Behaviour Formal and  
Informal organisation Group Dynamics and terms

### **Unit-IV**

Motivational Process and Theories Communication Technology and Interpersonal process  
Leadership process and style and T.Q.M.

### **Unit-V**

Decision making behaviour, Decision making techniques creativity.

### **References:**

- 1) Psychosocial Dimensions for management by T.V.Rao
- 2) Appraising and Developing Managerial Performance Management and Organisational Behaviour by Laurie J. Mullins

3) Managerial Behaviour and Effectiveness by E Ananda Raja, N R V Prabhu, P Kameshwara Rao

4) Managerial Behaviour by O.P. Khanna

**Course Outcome:**

- 1) It emphasis on understanding of the issues, problems and practice of managing, working and organising across cultures in organisations.
- 2) It develops the understanding of psychosocial dimensions in people of organization to sustain relationship.
- 3) It contributes in developing interpersonal behaviours.
- 4) The subjects help students to learn organizational whesiveness, pursuing goal and understand behaviour.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-304</b>
<b>Course Title</b>	<b>: Food Processing-I</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### **Course Pre-requisite:**

To learn the basic knowledge of Food Processing-I, requires pre-knowledge of Food chemistry (FTC-201), Food biochemistry and nutrition (FTC-202), instrumentation and process control (CHC-309) and principles of food preservation (FTC-301).

### **Course Objectives:**

1. To study milling technology of wheat, rice, corn, starch
2. To study milling technology of legumes processing and & oil seeds (oil extraction, refining, hydrogenation)
3. To study manufacturing technology for baked and confectionery products (biscuits, bread, cake, dough rheology, chocolate, candy, cocobean processing).
4. To study process technology for preparing convenience and fast foods, Snack foods and special foods( baby foods, weaning food, space foods, IM foods and instant foods).

### **Course Objectives:**

#### **Unit-I**

**(10 hrs)**

Process Technology of cereals grains and their fractions. Process technology of milling of wheat, rice and corn. Isolation and processing of starch, Byproducts of milling industry. Malting of cereals, packaging of cereal products.

**Unit-II****(10 hrs)**

Technology of milling of legumes and oil seeds, Techniques of oil extraction, refining & hydrogenation. Manufacture of margarine. Processing of oilseed cake for food.

**Unit-III****(10 hrs)**

Process technology of baked goods, selection of raw material and quality control, rheology of dough, changes during dough formation, fermentation and baking. Manufacturing of bread, biscuit, cookies, cracker, & cakes. Quality control in finished goods & packaging.

**Unit IV****(10 hrs)**

Process technology of snack food and fast food. Manufacturing of breakfast cereals, Puffed cereals, extrusion process and extruded products. Fast foods & convenience foods. Packaging of snack foods.

Special foods: weaning & baby foods, space foods, IM foods, agglomeration technique & instant food.

**Unit-V****(10 hrs)**

Process technology of cocoa. Manufacturing of dark and white chocolate & milk chocolate. Confectionary technology: manufacturing of hard boiled candies, jelly, toffee, caramel, chikki.

**Books recommended:**

1. Grain storage part of system edited by sinha R.N & Muir W E. AVI publishing co. inc Westport connecticute 1973.
2. Tech. of cereal with special refrence to wheat by Kenny N.I pergamon press, Oxford 1975.
3. Cereal tech. by matz samual A, AVI publishing co. inc Westport connecticute 1969.
4. Modern methods of cocoa & chocolate mfg. by wetters,H W, J. A churchuill, 40 gloucester, place,protmen square 1930.
5. Wheat chemistry and tech. edited bypormeranz Y, American asso.of cereal chemists Minnesota 1978.
- 6.Modern cereal chemistry bykent jones D W & amos A N , food trade press ltd 7, Garrick street, W,c.2. london, 1967
7. Snack food tech. by matz samual A, AVI publishing co. inc Westport connecticute 1976.

8. Bakery material & methods by Daniel A.R Macleam & sons ltd. London 1947.
9. A manufacturer of biscuits cake, & wafers by british J & Grosphicrre, sir isaae pitman & sons ltd London 1932.
10. Sugar confectioner & chocolate manufacturer by E B Jackson & Less R Leonand Hill Books 24, market square alyesburry.
11. Essential of Food Science : Vickie.A.Vaclavik
12. Practical baking by Sultan W.J., AVI publishing Co. Inc. 1969.
13. Extrusion of Foods, Vol. I and II by J.M. Harper, CRC Press.

**Course Outcomes:**

1. The students learnt the milling technology of wheat, rice, corn, malting of grains and biproducts of milling.
2. The students will able to understand,milling of legumes and extraction of oil, its refining, hydrogenation.
3. Student will gain knowledge of preparing bakery products like biscuits and cocoa processing.
4. Student will gain knowledge of preparing special foods, Convenience and fast food, and Snack foods.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-304</b>
<b>Course Title</b>	<b>: Food Processing-I</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 1.5</b>

**Course Pre-requisite:**

To learn the practical knowledge of Food Processing-I, requires pre-knowledge of Food chemistry (FTC-201), Food biochemistry and nutrition (FTC-202), instrumentation and process control (CHC-309) and principles of food preservation (FTC-301).

**Course Objectives:**

1. To analyze, legumes, cereals and oilseeds.
2. To prepare various bakery products
3. To prepare various snack food and Instant mixes
4. To prepare various chocolate and confectionary product
5. To prepare various jelly and extruded food.

**Course Objectives:**

Analysis of cereal, legume, oil seed and starch

Preparation of biscuits, bread and cake

Preparation of snack food and Instant mixes

Preparation of chocolate and confectionary product

Preparation of caramel and chikki

Preparation of jelly and extruded food

**Course Outcomes:**

1. Students are able to analyze, legumes, cereals and oilseeds.
2. Students are able to prepare bakery products
3. Students are able to prepare snack food and Instant mixes
4. Students are able to prepare chocolate and confectionary product
5. Students are able to prepare jelly and extruded food.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-305</b>
<b>Course Title</b>	<b>: Food Biotechnology</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

**Course Pre-requisite:**

To learn the basic knowledge of Food Biotechnology requires pre-knowledge of Food microbiology and molecular biology (FTC-302), food biochemistry and nutrition (FTC- 202) and instrumentation and process control (CHC-309).

**Course Objectives:**

1. To acquire the knowledge of r-DNA technology, application, GM foods and Biotech crops.
2. To study production of biomass: baker's yeast, algae, mushroom, SCP, organic chemicals, and secondary metabolites (antibiotics, enzymes, flavors, etc.)
3. To acquire the knowledge of different types of fermented foods and their preparation, like alcoholic beverages, dairy products and soya based oriental foods.

**Course Objectives:**

**Unit -I** **(10 hrs)**

Screening of microorganisms for biotechnological process, structure, function and types of nucleic acid. DNA replication, protein synthesis. Introduction to r-DNA technology, & its application. GM foods and Biotech crops.

**Unit- II** **(10 hrs)**

Production of biomass: Production of baker's yeast, starter culture, algae mushroom and single cell protein from different substrate.

**Unit - III** **(10 hrs)**

Production of organic chemicals: production of industrial alcohol, acetic acid, citric acid, vinegar, acetone butanol by fermentation.

**Unit - IV****(10 hrs)**

Production of secondary metabolites: Production of Penicillin antibiotics, enzyme polysaccharide, flavor and fragrances. Introduction to tissue culture.

**Unit - V****(10 hrs)**

Fermented foods:

Types of food fermentation; Process tech for alcoholic beverage. Types and processing of alcoholic beverage. Modern brewing technology.

Fermented Dairy products

Oriental fermented food, Soya sauce, Tempeh, Tofu, Idli

**Recommended Book:**

1. Industrial microbiology by Casida L.E Jhon Wiely and sons Inc new York 1964.
2. Industrial microbiology by Presscot & Dunn, McGrow Hill Book co new York,1940
3. Biotechnology, B. D Singh Kalyani publishers, ludhiyana, 1999.

**References:**

1. Industrial fermntation vol 1& 2by underkoffler L.A Chemical publishing co. Inc. 212 , fifth Avenue new York 1954.
2. Microbial tech. vol 1&2 by peppler.
3. Biotechnology: food fermentation Ed. V. K Joshi, Ashok Pande Educational Publisher & distributors New Delhi, 1999.

**Course Outcomes:**

1. The students will be able to learn production of biomass, like Baker's yeast, algae, mashroom.
2. The students will learn production of organic chemicals like, industrial alcohol, acetic acid, citric acid, vinegar, acetone butanol.
3. Students will learn production of secondary metabolites, like Penicillin, enzyme polysaccharide and flavor.
4. The students will be able to prepare, alcoholic beverages, dairy products and soya based oriental foods.
5. The students will be to learn screening of microorganisms for biotechnological process
6. The students will acquire knowlwdge of r-DNA technology, GM foods and Biotech crops and tissue culture.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: FTC-305</b>
<b>Course Title</b>	<b>: Food Biotechnology(PR)</b>
<b>Course Type</b>	<b>: Practical</b>
<b>Total Hrs</b>	<b>: 03</b>
<b>Course credit</b>	<b>: 1.5</b>

**Course Pre-requisite:**

To learn the practical knowledge of Food Biotechnology requires pre-knowledge of Food microbiology and molecular biology (FTC-302), food biochemistry and nutrition (FTC- 202) and instrumentation and process control (CHC-309).

**Course Objectives:**

1. To produce, baker's yeast, mushroom, citric acid, ethanol and wine.
2. To prepare idli and soya products
3. To prepare cheese and yoghurt
4. To learn immobilization of enzymes
5. To study fermenter or bioreactor
6. Detection of alfatoxin

**Course Objectives:**

Production of Baker's yeast,

Fermentative production & estimation of ethanol from suitable substrate.

Citric acid production

Preparation of idli/tofu/ soy sauce by fermentation process

Preparation of cheese and yoghurt

Detection of alfatoxin in peanuts

Preparation of wine

Immobilization of enzymes and its application.

**Books recommended:**

1. Laboratory Manual in biochemistry by J. Jayaraman, Madurai kamraj university  
New Age International (P) Ltd. Publishers 1999 New Delhi.
2. Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom Production  
Technology, K.R. Aneja, New Age International Publishers, Third Edition, 2002

**Course Outcomes:**

1. Students are able to produce baker's yeast, mushroom, citric acid and ethanol
2. Students are able to prepare idli and soy products
3. Students are able to prepare cheese and yoghurt
4. Students are able to detect aflatoxin in contaminated grain.
5. Students are able to learn immobilization of enzymes
6. Students are able to prepare wine.

**Choose any one subject from following two Electives:**

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: Elective-II, FTL-308</b>
<b>Course Title</b>	<b>: Treatment and Disposal of Food Industrial Waste (Elective-II)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

**Course Pre-requisite:**

To learn the basic knowledge of treatment and disposal of food industrial waste, requires pre-knowledge of Microbiology and molecular biology (FTC-302), instrumentation and process control (CHC-309) and physical chemistry (BSC-103).

**Course Objectives:**

1. To learn Primary, secondary and tertiary process for treatment of industrial effluent
2. To learn composition and health hazards of pollutants in effluent
3. To learn principle, design and working of various biological process for treatment of industrial effluent
4. To learn value addition to waste through effluent treatment
5. Estimation of kinetic coefficients for treatment.

**Course Objectives:**

**Unit-I**

**(10 hrs)**

Physical, chemical and biological characteristics of food industry waste. Composition of food industry waste.

**Unit-II**

**(10 hrs)**

Classification and application of waste water treatment methods. Treatment process flow sheets. Process design criteria.

**Unit-III**

**(10 hrs)**

Role of micro-organisms in food industry waste. Application of kinetics to biological treatment. Determination of kinetic coefficients.

**Unit -IV****(10 hrs)**

Activated sludge process. Suspended-Growth nitrification. Aerobic Aerated Lagoons. Aerobic digestion. Aerobic stabilization ponds.

**Unit-V****(10 hrs)**

Trickling filters, Roughing filters, Rotating biological contactors, Packed bed reactors, Byproduct recovery and value addition to the waste.

**Books Recommended:**

Waste Water Engineering: Treatment, Disposal and Reuse by Metcalf &Eddy (Second Edition)

**Course Outcomes:**

1. The students will learn and gain the basic knowledge of composition of industrial effluent and health hazards of pollutants in effluent
2. The students will learn various Primary, secondary and tertiary process for industrial effluent treatment
3. The students will learn principle, design and working of various biological process for treatment of industrial effluent
4. The students will learn various value addition to waste through effluent treatment
5. The students will be able to calculate kinetic coefficients for waste water treatment.

<b>Department</b>	<b>: Department of Food Technology</b>
<b>Course code</b>	<b>: Elective-II, FTL-309</b>
<b>Course Title</b>	<b>: Fruits and Vegetable Processing Technology (Elective-II)</b>
<b>Course Type</b>	<b>: Theory</b>
<b>Total Hrs</b>	<b>: 04</b>
<b>Course credit</b>	<b>: 04</b>

### **Course Pre-requisite:**

To learn the basic knowledge of treatment and disposal of food industrial waste requires pre-knowledge of principles of food preservation (FTC-301), microbiology and molecular biology (FTL302), mechanical operations (CHC 202), food chemistry (FTC201), advanced technology of food packaging (FTL306) and mass transfer operations (CHL308).

### **Course Objectives:**

1. To learn quality assessment of fruit & vegetables, preservation, and storage to avoid spoilage loss.
2. To learn unit operations and equipments for extraction, filling, sealing, and bottling of F- V products, washers and heat exchangers.
3. To learn process technology for F-V products: concentrate, puree, jam, jelly, marmalade, preserves, candid fruits, pickles, chutneys, RTS, and carbonated beverages.
4. To learn Aseptic packaging of F-V products, retortable and flexible packaging of F-V products , by-products , waste treatment of F-V industrial effluent
5. To learn, FSSAI, international standards WHO, FAO, Codex alimentarius Specification of various F-V products of F-V products, good manufacturing practices (GMP).

### **Course Objectives:**

#### **Unit- I**

**(10 hrs)**

Quality assessment of fruit & vegetables. Physiology of plant tissue, Plant pigments. Effect of processing on color and texture, Post harvest changes in climetric and non climetric fruits, Preservation of fruits and vegetables by refrigeration and waxing, CA & MA storage and dehydration of fruits and vegetables.

**Unit – II****(10 hrs)**

Fruits and vegetable processing and machinery and equipments, rotary washer , bottle washing, abrasive peeler, screw type juice extractor, pulper, filling machine, sealing machine, exhaust box, retort, can reformer, flanger and seaming machine, plate and tubular heat exchanger, vacuum evaporator, various types of dryers, plate and frame filter press, jacketed kettles.

**Unit - III****(10 hrs)**

Processing and canning of fruits and vegetables and their products, technology for concentrate, puree, jam, jelly, marmalade, preserves, candid fruits, pickles, chutnies, RTS, and carbonated beverages.

**Unit - IV****(10 hrs)**

Aseptic processing and packaging of fruits and vegetable products, retortable and flexible packaging of F and V, by-products of F and V, waste treatment of F and V processing industries.

**Unit -V****(10 hrs)**

Specification of various fruits and vegetable products, FSSAI, international standards WHO, FAO, Codex alimentarius of F and V processed products, good manufacturing practices (GMP).

**Books Recommended:**

1. The Fundamental of Food Engg. By Charm S. E., The AVI Publishing co. Inc. Westport Connctiout 1963.
2. Principles of Food Preservation Part II By Owens R. Fenemma
3. Technology of Food Preservation: By Desrosier Norman W. AVI Publishing Co. Inc. London.
4. The Freezing Preservation of Foods Vol. 1, 2, 3 & 4 edited by Eople M. J. & Co. Inc. Westport Conncticut 1964.
5. Radiation Technology by Desrosier, N.W. AVI Publishing Co. Inc, 1960.
6. Modern Technology on Food Preservation: NIIR BOARD: Asia Pacific Business Press Inc.
7. Preservation of fruits and vegetables by Girdharilal and Sidappa ICAR new Delhi

**Course Outcomes:**

1. Students were able to learn quality assessment of fruit & vegetables, preservation, and storage of F-V products
2. Students were able to learn various unit operations and equipments used for extraction, filling, sealing, and bottling of F- V products, washers and heat exchangers.

3. Students were able to learn processing of F-V products: concentrate, puree, jam, jelly, marmalade, preserves, candid fruits, pickles, chutnies, RTS, and carbonated beverages.
4. Students were able to learn Aseptic packaging of F-V products, retortable and flexible packaging of F-V products and by-products , treatment of F-V industrial effluent
5. Students were able to learn FSSAI, international standards WHO, FAO, Codex alimentarius Specification of various F-V products of F-V products and good manufacturing practices (GMP).