

Syllabus of Third Year

B. Tech. (Food Technology)

(Overall Structure and Revised Syllabus w. e. f. 2020-2021)

Faculty of Science and Technology



**University Institute of Chemical Technology
Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon**

(Academic Year 2020 – 21)

**Third Year B. Tech. (Food Technology)
Revised Syllabus w.e.f. 2020-21**

Fifth Semester

Course Code	Title of Course	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHL-314	Mass Transfer Operations	03	-	03	-	-	03
CHP-315	Mass & Momentum Transfer Operations	-	-	-	03	1.5	1.5
CHL-312	Process Design and Project Management	03	-	03	-	-	03
FTC-301	Principles of Food Preservation	03	-	03	03	1.5	05
FTC-302	Microbiology and Molecular Biology	03	-	03	03	1.5	05
Elective I	Open Elective	03	-	03	-	-	03
NC-303	Essence of Indian Traditional Knowledge	-	-	-	-	-	NC
Total							19.5

Sixth Semester

Course Code	Title of Course	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHL-316	Chemical Reaction Engineering	03	01	04	-	-	04
HML-309	Psycho-social Dimensions of Industrial Management	03	-	03	-	-	03
FTL-303	Food Biotechnology	03	-	03	-	-	03
FTP-304	Food Processing and Biotechnology	-	-	-	06	03	03
Elective II	Open Elective	03	-	03	-	-	03
Elective III	Professional Core Elective	03	-	03	-	-	03
Total							19

List of Electives

Elective I (Open Elective)

FTL-305 Advanced Technology in Food Packaging
 OTL-305 Technology of Perfumery and Cosmetics
 PTL-305 Specialty Pigments and Additives in Coatings
 PLL-304 Polymer Rheology
 CHL-320 Nanoscience and Nanotechnology

Elective II (Open Elective)

FTL-306 Treatment and Disposal of Food Industrial Waste
 OTL-306 Biochemistry & Biotechnology of Lipids
 PTL-306 Technology of Printing Inks
 PLL-305 Plastics Waste Management
 CHL-321 Water Conservation and Management

Elective III (Professional Core Elective)

FTL-307 Food Processing-I
 FTL-308 Fruits and Vegetable Processing Technology

FIFTH SEMESTER

Course Code	: CHL-314
Course Title	: Mass Transfer Operations
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course objectives:

Objective of this subject is to expose students to understand the basic mass transfer operation like diffusion, absorption, drying, humidification distillation, liquid-liquid extraction, adsorption, leaching and crystallization and its application to chemical engineering.

Pre-requisites:

Material and energy Balances Computations (CHL-206)

Course Content:

Unit-I

Constitutive laws of diffusion: Equimolecular counter diffusion and diffusion in stationary gas; Diffusivities in liquid, vapor and gases; Local and average overall mass transfer coefficients
Interphase mass transfer process: Mass transfer equilibrium, Mass transfer theories, Mass transfer and chemical reaction

Material balance: Steady state co-current and counter current processes, stage wise and differential contacts, Number of theoretical stages, Stage efficiency, Height of transfer units.

Unit-II

Distillation of binary mixtures: Vapor-liquid equilibria, Raoult's law, X-Y, T-X-Y & H-X-Y diagrams, Boiling point diagram and azeotropes

Types of distillation, Fractionating column and multistage column, McCabe-Thiele method, Operating and feed lines, feed conditions, reflux ratio, minimum and optimum reflux ratio, Tray and column efficiency.

Unit-III

Absorption: Solubility, choice of solvent, concept of driving force and mass transfer coefficient, Material balance for transfer of one component -counter current and concurrent flow, minimum gas-liquid ratio for absorber. absorption with & without chemical reaction. Determination of height of columns, transfer units and HETP.

Packed towers: General construction & working, types of packing merits & demerits, operational difficulties, pressure drop & limiting G-L flow rates.

Plate towers: General construction & working, types of plate, merits and demerits, operational difficulties

Unit IV

Liquid-Liquid Extraction: fundamentals, solvent selection, triangular diagram representation, Single stage extraction- maximum and minimum solvent, Equipment for liquid-liquid extraction. (Mixer settler, Rotating Disc Contractor, Packed column, spray column) equipment selection criteria.

Solid-Liquid Extraction fundamentals, Solvent selection, equilibrium relationship, triangular diagram representation, single stage operation,

Unit-V

Crystallization: Theory of solubility and crystallization, phase diagram (temp/solubility relationship), methods of achieving Supersaturation, phenomenon of crystal formation, crystal structure. Material & heat balance over crystallizer & related problems.

Drying: Drying mechanism, Constant rate and falling rate periods, drying rate curves, estimation of drying time, moisture contents, drying equipments- rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers.

Text/ Reference Books

1. Dutta, Binay K. *Principles of mass transfer and separation processes*. PHI Learning Pvt. Ltd., 2007.
2. Treybal, Robert E. "Mass transfer operations." *New York* 466 (1980).
3. Cussler, Edward Lansing, and Edward Lansing Cussler. *Diffusion: mass transfer in fluid systems*. Cambridge university press, 2009.
4. Foust, Alan S., Leonard A. Wenzel, Curtis W. Clump, Louis Maus, and L. Bryce Andersen. *Principles of unit operations*. John Wiley & Sons, 2008.
5. Geankoplis, Tansport. "Processes and unit Operations, 3rd Editions Prentice hall." *Englewood Cliffs, NJ* (1993).

Course Outcomes (COs):

Upon completion of the course students will be able to:

1. **Recognize** laws of diffusion, **apply** them in mass transfer operation and **estimate** the number of stages in distillation.
2. **Interpret** the fundamentals of gas absorption and **evaluate** the height of packed column for absorption.
3. **Analyze** liquid–liquid extraction and **solve** problems on single stage extraction.
4. **Understand** the basics of crystallization and drying technology.

Course Code	: CHP-315
Course Title	: Mass & Momentum Transfer Operations
Course Type	: Practical
Total Hrs/week	: 03 hr (PR)
Course Credit	: 1.5

Course objectives:

To provide the hand-in-hand experience of lab-scale experiments on various types of equipment based on the theoretical understanding and its application learned in theory course.

Experiments:

1. Determination of diffusivity of Acetone in air; Acetic acid in water.
2. Determination of rate of drying of given sample.
3. Determination of Mass transfer coefficient in wetted wall column.
4. Determination of loading and flooding point in packed column.
5. Validation of Rayleigh equation (Differential distillation).
6. Determination of distribution coefficient of Single stage liquid -liquid extraction for Acetic acid- water-benzene system.
7. Determination of Reynolds Number & prediction of flow behavior.
8. Determination of coefficient of discharge of Venturimeter and Orifice Meter.
9. Determination of the coefficient of discharge for Triangular, Rectangular and Trapezoidal Notch.
10. Study of characteristics of pumps & compressors (Centrifugal & Reciprocating)

Reference Books

1. Departmental Practical Manual.

Course Outcomes (COs):

Upon completion of the course students will be able to:

1. **Develop** the ability regarding analytical and data interpretation skills.
2. **Understand** the scaling approach of understanding from Experimental to Industry applications.
3. **Plan** an appropriate approach to experiment work and **justify** plans in the light of preliminary findings.
4. **Demonstrate** safe working in the choice of method and apparatus.

Course Code	: CHL-312
Course Title	: Process Design and Project Management
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course objectives:

The objective of the course is to provide students with a firm grasp of the essential principles of management, project identification project feasibility and project scheduling technique with suitable examples. Students will able to understand HAZOP design and read the PID of the plant. Students will able to understand economics for chemical processes.

Prerequisites:

Industrial Management and Economics (HML-202)

Course Content:

Unit -I

Project identification and its feasibility; project testing based on viability, risk & cost estimation; evaluation of project by different methods on the basis of visibility i) Net present value method, ii) Method of rate of return on initial investment, iii) Pay out period, iv) Method of discount cash flow, v) Capitalized cost method, vi) Internal rate of return method, vi) Break even chart; evaluation of project by different methods on the basis of risk i) Profitability index, ii) Demand fore casting, iii) Standard deviation approach; evaluation of project by different methods on the basis of cost i) Preparation of cost sheet and statements, ii) Preparation of profit loss statement.

Unit –II

New developments in management, CPM & PERT, principle and objective of CPM and PERT network diagram for calculation time duration.

Linear programming problem (Numerical based on each method) i) General simplex method ii) Primary & dual technique method iii) Direct simplex method iv) Graphical method.

Unit –III

Cost analysis, fixed capital, working capital, preparation of store ledger account by pricing issue methods, LIFO, FIFO, simple average, weighted average.

Depreciation, significance of inadequacy and obsolescence, and depreciation methods.

Unit -IV

Layout and location, objective, principle; layout and location factors, equipment layout diagram (ELD); tank firm cum utility block diagram for different processes.

Unit -V

HAZOP: Introduction and guide word, application of HAZOP to processes with examples. PID: Basic symbols for various piping and instruments; development of PFD, P&ID, PDS for different processes.

Text/ Reference Books

1. S.D. Dawande *Process equipment Design*. Denett and Co Fifth Edition
2. B.V. Pathak & M.S. Mahajan *Industrial Organization & Management*, Nirali Prakashan First Edition 1986

3. Peters, Max Stone, Klaus D. Timmerhaus, Ronald Emmett West, Klaus Timmerhaus, and Ronald West. *Plant design and economics for chemical engineers*. Vol. 4. New York: McGraw-Hill, 1968.
4. Shreve, Randolph Norris, and Joseph A. Brink Jr. *Chemical Process Industries*. No. 4th Edition. McGraw-Hill Book Co., 1977.
5. Dryden's *Outlines of Chemical Process Technology*, Third Edition, 1997
6. D.B.Dhone *Plant Utilities* Nirali Prakashan, First Edition 2008.

Course Outcomes (COs):

Upon completion of the course students will be able to:

1. **Evaluate** feasibility of project.
2. **Apply** various methods of profitability evaluation.
3. **Identify** the new development in project management and optimization techniques.
4. **Apply** HAZOP analysis for safety of the process.

Course Code	: FTC-301
Course Title	: Principles of Food Preservation
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course Objectives:

- 1.To study causes of food spoilage.
- 2.To study newer technology of Thermal / Nonthermal processing of food.
- 3.To study drying and dehydration of foods.
- 4.To study freezing and cold storage of food.

Course Content:

Unit –I:

Food Spoilage: Intrinsic and Extrinsic factors affecting food spoilage. Basic principles and methods of food preservation

Preservation by chemicals, bio-preservative, antimicrobial, hurdle technology.

Unit-II:

Thermal processing of Foods: Newer techniques in thermal processing- Retort processing, UHT, Extrusion hot and cold.

Newer techniques of Non thermal processing: high pressure processing, Ohmic heating, pulse electric field, dielectric heating, infrared, microwave heating.

Unit – III:

Dehydration: Water activity for food and its significance in food preservation, dehydration and drying of foods, different dryers - Cabinet dryer, fluidized bed dryer, Spray dryer, Microwave dryer. Osmo-air dehydration, IM food.

Unit-IV:

Concentration: Freeze concentration, open pan vacuum concentration, freeze drying, membrane concentration.

Irradiation: Preservation by ionizing radiation; Ultrasonic

Preservation by fermentation: curing, pickling; smoking.

Unit-V:

Low Temperature preservation of foods: Planks equation for predicting rate of freezing. Freezing and Cold Storage, including cryogenic freezing, properties of frozen foods, IQF, Blast freezing, Types of thawing and their effect on food.

Textbooks

1. Potter, Norman N., and Joseph H. Hotchkiss. Food Science. Gaithersburg, MD: Aspen Publishers, 1998.
2. Owens R. Fenemma, Principles of Food Science: Physical Methods of Food Preservation Part II, Taylor & Francis Inc, 1975

3. Owen R. Fennema, Principle of food science, New York ; Basel : Dekker, 1975.
4. Grandison, Alistair S., and J. G. Brennan. Food Processing Handbook. Weinheim: Wiley-VCH, 2012

Reference Books

1. Fruits and vegetable processing by cruss.
2. Desrosier, Norman W. Technology of Food Preservation. Place of publication not identified: ED-TECH, 2018.
3. Radiation Technology by Desrosier, N.W. AVI Publishing Co. Inc, 1960.
4. Board, Niir. Modern Technology on Food Preservation. Delhi: Asia Pacific Business Press, 2004
5. Food processing Technology: Principle and practice- Fellow P. J. , CBS publishers 2005.
6. Srivastava, RP, and Sanjeev Kumar. Fruit and Vegetable Preservation: Principles and Practices. New Delhi: CBS Publishers & Distributors Pvt. Ltd., 1994..
7. Fellows, P. Food Processing Technology: Principles and Practice, 2000.
8. Lal, Girdhari, G. S. Siddappa, and G. L. Tandon. Preservation of Fruits and Vegetables. New Delhi: Publications and Information Division, Indian Council of Agricultural Research, 2011.

Course Outcomes:

1. Student **discriminate** and categorized the causes of food spoilage and their control
2. Students can **justify** newer technology in thermal processing and non-thermal processing of Foods
3. Students will be able to **explore** newer techniques dehydration of foods.
4. Students can **predict** rate of freezing

Course Code	: FTC-301
Course Title	: Food Preservation
Course Type	: Practical
Total Hrs/week	: 03 hr (PR)
Course Credit	: 1.5

Course Objectives:

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

Course Content:

Demonstration of food processing equipment's

To study the adequacy of blanching treatment of fruits and vegetables

Preservation of fruits squash by chemical preservation

Phosphatase test of pasteurized milk

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.

Reference Books:

1. Chemical analysis of food and food product by Pearson D, J.E.A Churchill, 104, Gloucester place, London, sixth edition 1970.
2. Rangana, S. Manual of Analysis of Fruit and Vegetable Products. New Delhi: Tata McGraw-Hill, 1979
3. Official Methods of Analysis of the Association of Official Analytical Chemists, The Association, 2000
4. Lal, Girdhari, G. S. Siddappa, and G. L. Tandon. *Preservation of Fruits and Vegetables*. New Delhi: Publications and Information Division, Indian Council of Agricultural Research, 2011.

Course Outcomes:

1. Students will be able to **Recognize** food preservation by dehydration, concentration, low temperature and chemical preservation
2. Students can **Explore** canning, pasteurization, blanching for high temperature preservation.
3. Student can **Demonstrate** food processing equipment's
4. Student can **prepare** cutout analysis of canned fruits

Course Code	: FTC-302
Course Title	: Microbiology and Molecular Biology
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course Objectives:

1. To study basics of microorganism, importance of food microbiology.
2. To study composition of nutrient media, isolation and enumeration of microorganism.
3. To study various techniques of controlling microorganisms.
4. To study occurrence of food intoxication and their preventive and control measures.

Course Content:

Unit I:

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

Unit II:

Nutritional requirement of micro-organism, composition of nutrient media, Enumeration of microorganism. Maintenance and preservation of industrially important microbial cultures.

Unit III:

Effect of temperature, dehydration, irradiation, and chemicals on growth of micro-organisms, control of microorganism by high and low temperature, control of microorganisms by physical and chemical methods. Determination of TDT curve, D, Z and F value.

Unit IV:

Foodborne infection, Food mycotoxin their sources, toxicity, symptoms, preventive and control measures.

Unit V:

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

Text Book

1. Prescott, Samuel Cate, C. G. Dunn, and G. Reed. Industrial Microbiology. New York: MacMillan, 198
2. Pelczar, Michael J., Eddie C. S. Chan, and Noel R. Krieg. Microbiology. New Delhi: Tata McGraw-Hill, 2010.
3. Frazier, William C., and Dennis C. Westhoff. Food Microbiology. London: McGraw-Hill, 1988

Reference Books:

4. Food Processing Operation By M.A. Joslyn and J.L.Held, The AVI publishing co. Inc. Westport.
5. The Microbiological Safety of Food Edited by B. C. Hobs. J. H. E. Christian(1972), Academic Press.
6. George, Borgstrom. Principles of Food Science. New York: Mackillan Co., 1968.
7. Desrosier, Norman W. Technology Of Food Preservation. Place of publication not identified: ED-TECH, 2018.
8. Balachandar, D., and R. Thamizh. Vendan. Introductory Microbiology. New Delhi: New India Publishing Agency, 2007.

Course Outcomes:

1. Students will be able to **prepare** media for microbial growth, isolation and characterization of microorganisms.
2. Student can **outline** the techniques of control of micro-organisms by physical, high temperature and chemical methods.
3. Students will able to **diagnose** food infection/ intoxication and their control.
4. Students can **access** spoilage of fresh and processed food.

Course Code	: FTC-302
Course Title	: Microbiology and Molecular Biology
Course Type	: Practical
Total Hrs/week	: 03hr (PR)
Course Credit	: 1.5

Course Objectives:

1. To study composition of nutrient media growth, isolation and characterization of microorganism.
2. To study enumeration of microorganisms.
3. To study isolation techniques.
4. To study microbiological examination of water and processed foods.

Course Content

Staining Techniques

Isolation of microbes from food sample by Streak Plate, Pour Plate, Spread Plate

CFU, yeast and mold count

Measurement of antimicrobial activity

Evaluation of microbial quality of specific Fruit & Vegetable product and water sample.

Study of milk microbiology.

Reference Books:

1. Jay, James M. Modern Food Microbiology. New York: Springer, 2005.
2. Ward, Owen P. Fermentation Biotechnology: Principles, Processes and Products. Chichester: John Wiley & Sons Ltd., 1995.
3. Comprehensive Biotechnology by Murvay & Mooyonng academic press.
4. Aneja, K. R. Modern Food Microbiology. Noida: Medtech A division of scientific international, 2018.

Course Outcomes:

1. Students will be able to **interpret** micro-organisms by staining techniques.
2. Students will be able to **analyze** various isolation techniques of microorganisms.
3. Students can **estimate** CFU count in foods.
4. Students will be able to **examine** microbial quality of water and processed foods

Elective-I (Open Elective)

Course Code : FTL-305

Course Title : Advanced Technology in Food Packaging

Course Type : Theory

Total Hrs/week : 03 hr (TH)

Course Credit : 03

Course Objectives:

1. To study basic packaging materials, their properties, types of packaging, sealing and lamination process.
2. To study newer packaging technologies used for food products.
3. To estimate shelf life of packaged products.
4. To study packaging of soft drink and alcoholic beverages.

Prerequisites: ----Not Applicable----

Course Content:

Unit –I

Packaging as a method for conservation and protection of foods, different packaging material and their properties including barrier properties, strength properties, optical properties etc. Glass, Aluminium, tin, paper, plastic and composites. Sealing of metallic and plastic containers. Types of food packaging

Unit –II

Flexible packaging, laminated packaging and retortable pouches and biodegradable packaging material. Concept and calculation of shelf life of laminate, wine in PET, glass bottle; shelf life based on browning, vitamin loss and microbial count in food container. Safety and testing of packaging containers.

Unit –III

Active packaging system: - Packaging requirement for different moisture level food products, Aseptic processing and packaging of fruits & vegetables, milk and milk products

Unit – IV

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

Unit –V

Packaging of soft drink, alcoholic beverages, distilled spirits, frozen food, future trends in food packaging: intelligent/ smart packaging.

Text/ Reference Books

1. Handbook of food packaging by F. A Paine and H.Y paine., Publisher: Blackis and Son Ltd London (1983)
2. Food Packaging Principles and Practice: Gordon L. Robertson
3. Modern processing and distribution system for food edited by F. A Paine
4. Food and packaging interaction by Risch. S. H., Publisher: American chemical Society, Washington (1991)

5. Packaging materials and containers by Paine F. A., Publisher: Blackis and sons Ltd, London (1983)
6. Mathlouthi, M. Food Packaging and Preservation. Gaithersburg: Aspen, 1999
7. Paine F. A . Packaging media Publisher: Blackis and son Ltd; Bishop Briggs (1977)
8. Bureau, G., and J. L. Multon. Food Packaging Technology. New York, n.d. (1996)
9. Chemistry of Food Packaging by Swalam C.M., American Chemical Society, Washington D. C. 1974.
10. Packaging. Rockport, MA: Rockport Publishers, 1995.

Course Outcomes (COs):

Upon completion of the course students will be able to:

1. **Recognize** and **classify** food packaging materials and their use.
2. **Differentiate** active packaging, aseptic packaging, MAP, vacuum packaging, smart packaging, microwavable packaging.
3. **Estimate** shelf life of food packaged.
4. **Device** packaging of, soft drink, alcoholic beverages, and frozen food.

Elective-I (Open Elective)

Course Code : OTL-305

Course Title : Technology of Perfumery and Cosmetics

Course Type : Theory

Total Hrs/week : 03 hr (TH)

Course Credit : 03

Course Objectives: This course provides a thorough knowledge about different essential oil, perfumery synthetics and cosmetic ingredients. Students shall acquire various extraction methodologies in recovery of essential oils, their physio-chemical properties and applications. Also, the course will cover raw material for different cosmetic preparations.

Prerequisites: ---Not Applicable---

Course Content:

Unit -I

Essential oils: Chemistry, source materials, production methods
Production, properties and applications of essential oils (Rose, Jasmine, Khus, Sandalwood, Palmarosa, Lemongrass, Peppermint, Orange)

Unit –II

Physio-chemical properties of essential oils: Colour, specific gravity, refractive index, optical rotation, solubility, congealing point, evaporation residue, acid value and ester value.
Analysis of essential oils: Alcohol, Aldehyde, Ketones and Phenol content.

Unit- III

Grading and standardization of essential oils; common adulterants and their detection.
Perfumery: History and its function, mechanism of smelling, classification & blending of perfume ingredients, perfumery isolates (Menthol, Geraniol and Musk)

Unit- IV

Synthetic perfumery materials and fixatives (Camphor, Thymol, Citral, Vanillin, Cumarin, Benzyl acetate, Benzyl benzoate)
Production, properties and applications: Hair oil & dyes, Shaving creams and Depilatories

Unit –V

Production, function and properties of cosmetic products: Face cream, Face powder, Talcum powder, Tooth paste/powder, Shampoo, Lipsticks and Nail polish

Text/ Reference Books

1. Valerie Ann Worwood “The Complete Book of Essential Oils and Aromatherapy”
2. Ernest Guenther “The Essential Oils” Volume-I
3. Sonia Malik “Essential Oil Research” Springer International Publishing
4. “Hand Book of Perfumes with Formulations” Engineers India Research Institute.
5. Nigel Groom “The Perfume Handbook” Springer
6. Steffen Arctander “Perfume and Flavor Materials of Natural Origin”
7. S.K. Singh “Handbook on Cosmetics (Processes, Formulae with Testing Methods)”
8. H. W. Hibbott. “Handbook of Cosmetic Science” 1st Edition

Course Outcomes (COs):

Upon completion of the course students will be able to:

1. **Understand** the fundamental of essential oils and **propose** methods of their production.
2. **Differentiate** the principles behind the physio-chemical analytical techniques in estimation of quality parameters of essential oils.
3. **Devise** the concepts of perfumery, blending of perfumes and **outline** the use of synthetic perfumery materials.
4. **Propose** the production techniques and **illustrate** the functions of ingredients in cosmetics products.

Elective-I (Open Elective)

Course Code : PTL-305

Course Title : Specialty Pigments and Additives in Coatings

Course Type : Theory

Total Hrs/week : 03 hr (TH)

Course Credit : 03

Course Objectives:

The Paint Technocrat will have in depth exposure to Specialty Pigments and Additives in Coatings.

1. The student will learn about the metallic and pearl effect and changes in pigmentary properties in reference to nano size.
2. The Technocrat will have exposure to Mechanism, dosing and Trade information of coating additives and surfactants.

Prerequisites: ----Not Applicable----

Course Content:

Unit -I Metallic, Interference and Cholesteric Pigments

Aluminum, copper, zinc dust, bronze, nickel stainless steel, lead powders and pastes, Nacreous, luminescent (fluorescent/phosphorescent) pigments-optical principles, substrate free pearlescent pigments, Special effect pigments based on mica (pigments formed by coating of substrates), pigments based on liquid crystal polymer

Unit -II Functional and Nano pigments

Antifouling pigments-cuprous oxide, other copper compounds, mercuric oxide, barium metaborate, organotin pigments, Manufacture and properties of nanopigments: alumina, silica, titanium dioxide, iron oxides, zinc oxides, silver, CaCO₃, etc. on Nano scale; variables affecting particle size aggregation and crystal structure. Their use as spacing extenders / functional pigments in paints, reinforcing agent in polymers, heat & wear resistant materials etc.

Unit - III Surfactants and surface additives

Anionic, cationic, non-ionic and amphoteric surfactants; polymeric surfactants, Gemini surfactants, HLB value, CMC, Kraft point. Role of surfactants as- emulsifier, wetting agents, dispersing agents. Surface additives, role of silicone and Fluoro surfactants as surface additives flow and levelling control agents,

Unit - IV Specialty additives in solvent borne coatings

Antisettling agents, additives for rheology control, adhesion promoters, antiskinning agents, light stabilizers (UV absorbers, antioxidants, HALS),moisture scavengers, slip additives,hammer and wrinkle finish additives, conductivity control additives etc.

Unit - V Specialty additives for Water Borne Coating

Auxiliary and coalescing solvents, neutralization agents, thickeners,antifoam, antifreeze-thaw, Preservatives (In- can/film)-fungicides, mildew agents, corrosion inhibitors etc.

Text/ Reference Books

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.

2. Swaraj, Paul. *Surface Coatings: Science and Technology*. J. Wiley & sons, 1985.
3. Karsa, D. R.; Davies, W. D., Eds., *Waterborne Coatings and Additives*, Royal Society of Chemistry, Cambridge, 1995.
4. Buxbaum, Gunter, ed. *Industrial inorganic pigments*. John Wiley & Sons, 2008.
5. Berte, J. N. "High Performance Pigments, ed Smith HM." (2002): 27-40.
6. Bieleman, Johan, ed. *Additives for coatings*. John Wiley & Sons, 2008.
7. Herbst, Willy, and Klaus Hunger. *Industrial organic pigments: production, properties, applications*. John Wiley & Sons, 2006.
8. Calbo, Leonard J. *Handbook of coatings additives*. 1987.

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Understand** the optical effects and **evaluate** Metallic, Interference and Cholesteric Pigments in coatings.
2. **Propose** synthesis methods of Functional and Nano pigments, and their applications in specialty coatings.
3. **Understand** constructive, corrective and comparative role of various additives in solvent borne, waterborne and other coatings.
4. **Assess** dosing and trade information of Additives in Coatings.

Elective-I (Open Elective)

Course Code : PLL-304
Course Title : Polymer Rheology
Course Type : Theory
Total Hrs/week : 03 hr (TH)
Course Credit : 03

Course Objectives:

1. To understand the flow properties of polymers in terms of various models to study viscoelastic behavior of the polymers.
2. To know the thermo viscoelastic behavior of polymers during processing and selection of design of processing device.
3. To understand the processing of various types of polymers, selection of device for processing on the basis of flow properties.

Prerequisites: ----Not Applicable----

Course Content:

Unit -I

Rheological Principles: Rheological Parameters, relationship between rheological parameters, Rheological systems: purely elastic, viscous, Types of fluids: Newtonian and Non Newtonian fluids, Viscoelastics fluids, Rheological or Constitutive equations.

Unit -II

Viscoelastic Nature of Polymers: Elasticity moduli and their time dependence, static and dynamic experiments to understand the time dependence, $\tan \delta$, its significance and method of determination, models of viscoelasticity, mechanical models such as Maxwell, voight, combinations of Maxwell and voight models to simulate viscoelastic behavior, salient features of molecular theories of viscoelasticity.

Unit -III

Glass Transition, Theories to determine the glass transition i.e. Dillatometric, Heat capacity, measurement, Thermomechanical, Measurement of modulus of elasticity, effect of Tg on molecular mass, kinetic chain flexibility and chemical constituent, Importance of Tg and Tm.

Unit -IV

Viscoelastic behavior of Polymer solution and melts stress-strain curves for Polymers, creep curves of Polymeric material, elastic deformation, irrecoverable follow deformation. Rubber like deformation, Time-temp superposition (WLF Equation)

Unit -V

Methods to determine shear viscosity by capillary, parallel plate and cone and plate Rheometer, Measurement of normal stresses, Application of rheology to polymer processing.

Text/ Reference Books

1. P.N.Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, George Godwin, Second Edition, 1981.

2. Richard C. Progelhof and James L. Throne, Polymer Engineering Principles, Hanser Publishers, New York, 1993.
3. John M. Dealy and Kurt F. Wissburn, Melt rheology and its role in plastics processing, Chapman, London, 1995.
4. R.S. Lenk, Polymer Rheology, Applied Science, London, 1978.
5. J.D. Ferry, Viscoelastic Properties of Polymers, John Wiley & Sons, New York, 1986.
6. Chang Dae Han. Rheology in Polymer Processing, Academic Press, New York, 1976.
7. R.J. Crawford, Plastics Engineering, Butterworth - Heinemann, Oxford, 1998
8. B.R. Gupta, Applied Rheology in Polymer Processing, Asian Books Pvt. Ltd. 1st Edition, 2005.

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Recognize** flow behavior of the polymers and various models used for determination of flow properties.
2. **Design** features of the processing device on the basis of processing parameter as temperature, pressure, shear rate.
3. **Select** the processing equipment with respect to change in polymer, polymer flow properties.
4. **Differentiate** the transition behavior of various polymeric materials.

Elective-I (Open Elective)

Course Code : CHL-320
Course Title : Nanoscience and Nanotechnology
Course Type : Theory
Total Hrs/week : 03 hr (TH)
Course Credit : 03

Course Objectives:

The objective of the course is to introduce students about emerging field of Nanoscience and Technology. Students will learn about properties of nanomaterials and their applications.

Prerequisites: ----Not Applicable----

UNIT-I

Quantum chemistry, Solid state Physics, Nanomaterial & Manufacturing, Renewable energy generation, Nanotechnology in drug delivery, Nanotechnology in cosmetics, Bio-nanotechnology, Nanotechnology & information technology, Nanotechnology in agriculture and food industry, Environmental nanotechnology, Nanotechnology Health risk.

UNIT-II

Synthesis methods of nanostructures: Top-Down and Bottom-up approach of synthesis, Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermal synthesis.

UNIT-III

Nanostructures and its applications: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide, Silver, Copper Nanoparticles) Nanowires Polymer-based Nanostructures including dendrimers, nanofillers like clay, CaCO₃, CaSO₄.

UNIT-IV

Nanocatalysis: Nanomaterials as catalysts for a variety of homogeneous and heterogeneous catalysis applications. Impact of the intrinsic properties of nanomaterials on catalysis, Various methods like Chemical Reduction Method, Thermal, Photochemical and Sonochemical Reduction Method, Applications of Nanocatalysis in Chemical Industry.

UNIT-V

Characterization techniques in analysing Nanomaterials: Scanning/transmission electron microscopy (SEM/ TEM), XRD, Atomic Force Microscopy, Particle size analyser (PSA) and their applications.

Text/ Reference Books

1. Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey A. Ozin, Andre C. Arsenault, Royal Society of Chemistry, Cambridge, UK, 2005.
2. Chemistry of Nanomaterials: Synthesis, Properties and Applications C. N. R. Rao, Achim Muller, A. K Cheetham, Wiley-VCH, 2004.
3. Metal Nanoparticles: Synthesis Characterization & Applications, Daniel L. Fedlheim, Colby A. Foss, Marcel Dekker, 2002.

4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong, Ying Wang, World Scientific, 2011.
5. Nanoparticles and Catalysis, Didier Astruc (Editor), Wiley-VCH Verlag GmbH & Co. KGaA, 2008

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Choose** appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties.
2. **Correlate** properties of nanostructures with their size, shape and surface characteristics.
3. **Select** appropriate analytical tools for characterization of nanomaterials.
4. **Appraise** on application of nanomaterials as catalyst.

Course Code	: NC-303
Course Title	: Essence of Indian Traditional Knowledge
Course Type	: Audit
Total Hrs/week	: ----
Course Credit	: NC

Course Objectives:

1. The course aims at imparting basic principles of thought process, reasoning with emphasis on sustainability connecting society and nature.
2. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
3. To focus on Indian Knowledge System, Indian perspective of modern scientific worldview and basic principles of Yoga and holistic health care system.

Prerequisites: ----Not Applicable----

Course Content:

Unit-I

Introduction to traditional knowledge: Traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, physical and social contexts in which traditional knowledge develop, historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, western knowledge. Indian personalities in traditional knowledge, linking science and the rural

Unit-II

Protection of traditional knowledge: Need for protecting traditional knowledge (TK), significance of TK protection, global mechanisms of protection and sharing, recognition and protection value of TK in global economy, role of government to harness TK.

Unit-III

Legal framework and TK: Scheduled Tribes and Other Traditional Forest Dwellers (Recognition Of Forest Rights) Act (2006); Plant Varieties Protection and Farmer's Rights Act (2001) (PPVFRAct); Biological Diversity Act (2002) and Rules (2004); Protection of Traditional Knowledge Bill (2016); Geographical Indicators Act (2003).

Unit-IV

Traditional knowledge and intellectual property: Systems of TK protection, Legal concepts for the protection of TK, Certain non IPR mechanisms of traditional TK, Patents and TK, Strategies to increase protection of TK, Global legal fora for increasing protection of Indian Traditional Knowledge.

Unit-V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Food and healthcare needs of Traditional societies, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Text/ Reference Books

1. Sengupta, Nirmal, Nirmal Sengupta, and Ghosh. *Traditional Knowledge in Modern India*. Springer India, 2019.
2. Jha, Amit. *Traditional knowledge system in India*. Atlantic Publishers & Distributors, 2009.
3. Basanta Kumar Mohanta and Vipin Kumar Singh *Traditional Knowledge System and Technology in India*, Pratibha Prakashan 2012.
4. Kapoor, Kapil, and Michel Danino. "Textbook of" Knowledge Traditions and Practices of India". *Ancient Science of Life* 32, no. 1 (2012): 59.

E-Resources:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Understand, correlate** and **explain** basics of Indian Traditional knowledge modern scientific perspective
2. **Recognize** the need and importance of protecting traditional knowledge.
3. **Propose** the various enactments related to the protection of traditional knowledge.
4. **Describe** the concepts of Intellectual property to protect the traditional knowledge.

Course Code	: CHL-316
Course Title	: Chemical Reaction Engineering
Course Type	: Theory
Total Hrs/week	: 03 hr (TH) and 01 hr (Tutorial)
Course Credit	: 04

Course objectives:

1. This course will highlight basic concepts of kinetics and rate laws along with interpretation of rate data.
2. The course will deal with problems involving design & rating of ideal reactors including heat effects, multiple reactions.
3. The course will also provide basic understanding of catalysts and their applications to industrial processes.

Pre-requisites:

Material and Energy Balance Calculations (CHL-206)
Chemistry-I (BSC-103)

Course Content:

Unit –I

Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity
Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

Unit –II

Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis.

Unit –III

Ideal reactors - generalized material balance, design equations, graphical interpretation.
Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors – solving design equations for constant and variable density systems, reactors in series and parallel.

Unit –IV

Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions.

Unit –V

Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterization of catalysts. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst .

Text/Reference Books

1. H. Scott Fogler *Elements of Chemical Reaction Engineering* 2nd Edition, Prentice Hall 2001.
2. Octave Levenspiel *Chemical Reaction Engineering* by, 3rd Edition, John Wiley & Sons 2001

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Design** chemical reactors involving heat effects optimally using minimum amount of data
2. **Fix** some problems related to operability and productivity.
3. **Apply** methods of Catalysts' synthesis and catalyst characterization
4. **Understand** and **interpret** kinetics data.

Course Code	: HML-309
Course Title	: Psycho-Social Dimensions of Industrial Management
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course Objectives:

1. To prepare and develop the students for successful career that meets the global Industrial and Corporate requirements.
2. To guide the students about perception and attitude development to excel in organisation setting
3. To provide an environment for students to work on Multidisciplinary projects as part of different teams to develop their team building capabilities like leadership, motivation, teamwork etc.
4. To introduce professional ethics and codes of professional practices in Industry.

Pre-requisites:

Industrial Management and Economics (HML-202)

Course Content:

Unit –I

Concept and meaning of organisation behaviour, Features & foundations of organisation behaviour, Role of organisation behaviour, Theories of organisation behaviour, Behaviour Process, Innovation & creativity in organization

U Unit –II

Perception: Meaning and definition, Factors influencing perception process, Perception Process, Perception and individual decision making, Nature of attitudes, Components of attitude, Formation of attitudes, Functions of attitudes, Work related attitudes: Job satisfaction & organizational commitment, Attitudes, values & organization behaviour

Unit –III

Motivation: Nature & Importance, Theories of Motivation, Content Theories and Process theories: Evaluation & criticism, Self-motivation

Unit –IV

Leadership: Nature, Leadership and management, Importance, Leadership styles and their implications, Trait and behavioural approach of leadership, Decision making: Nature, types & conditions of decisions, Decision making process & styles

Unit –IV

Nature and sources of ethics, Ethical dilemmas, Resolving dilemmas, Ethical decision making, Ways of managing ethics, Corporate social responsibility

Text/ Reference Books

1. Aswathappa, Kalupally, and G. Sudarsana Reddy. *Organisational behaviour*. Vol. 20. Himalaya Publishing House, 2009.
2. Martin, John. *Organizational behaviour and management*. Cengage learning EMEA, 2005.
3. Saiyadain, Mirza S. *Organisational behaviour*. Tata McGraw-Hill Education, 2003.

4. Mishra, MahaNarain. *Organisational behaviour*. Vikas Publishing House Pvt Ltd, 2001.
5. Robbins, Stephen P. *Organisational behaviour: global and Southern African perspectives*. Pearson South Africa, 2001.
6. Stoner, *Management-II*. Pearson Education India.

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Develop** the process of individual behaviour and perpetual process along with conditioning of thinking process
2. **Identify** the concept and process of motivation and leadership
3. **Correlate** human behaviour, social skills, innovations, and creativity to improve workplace dynamics.
4. **Develop** the knowledge of ethical considerations and administrative regulations by applying the theories and principles of Management in practice to improve performance of individual employee at a workplace.

Course Code	: FTL-303
Course Title	: Food Biotechnology
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

Course Objectives:

- 1.To study r-DNA technology, application in food industry.
- 2.To study production of baker's yeast, mushroom, SCP, organic acid, alcoholic beverages, vitamin
- 3.To study preparation of soya based oriental foods.

Course Content

Unit I:

Screening of microorganisms for biotechnological process, chemistry and biology of DNA, RNA and Proteins, DNA replication, transcription and translation in prokaryotes. r-DNA technology and its application for GM food and its safety issues.

Unit II:

Enzymatic Production of glucose, fructose, starch, SCP. Cultivation technology of mushroom and production of baker's yeast. Microbial culture for food fermentation, its maintenance.

Unit III:

Production of organic chemicals: production of industrial alcohol, lactic acid, citric acid, vinegar

Unit IV:

Microbial Production of vitamins (B₂, B₁₂), flavor and fragrance, polysaccharides and enzyme. Introduction to tissue culture.

Unit V:

Production of Alcoholic beverages: beer, wine and distilled beverages such as whisky, Rum Vodka.

Fermented Dairy products, Idli

Oriental fermented food: Soya sauce, Tempeh, Tofu,

Textbook:

1. Casida, L. E. J. R. Industrial Microbiology. Place of publication not identified: New Age International Pvt., 2015
2. Prescott, S. C., and Cecil G. Dunn. Industrial Microbiology. Jodhpur: Agrobios (India), 2011
3. Singh, B. D. Biotechnology. Ludhiana: Kalyani Publishers, 2016..
4. Handbook of Hydrocarbon and Lipid Microbiology. Berlin: Springer, 2010.
5. Joshi V. K., Technology of handling, Packaging, Processing, Preservation of fruits and vegetables, New India Publication agency New Delhi ,India, 2019

Reference Book:

1. Underkoffler L.A, R. J. Hickey, Industrial fermentation vol 1 and 2, Chemical publishing co. Inc. 212, fifth Avenue New York, 1954.
2. Peppler, H. J Ed. Microbial Technology. New York: Academic Press, 2004.
3. Joshi V. K, Ashok Pande, Biotechnology: food fermentation Educational Publishers & Distributors, 1999

Course Outcomes:

1. The students will able to **produce** Baker's yeast, mushroom, organic acids, alcoholic beverages, vitamin, SCP
2. The students will able to **recognizer**-DNA technology and its application in food industry
3. Students can **outline** the microbial production of glucose, fructose, starch, and **use** of microbial culture
4. Student can **outline** the process of making soya fermented products

Course Code	: FTP-304
Course Title	: Food Processing and Biotechnology
Course Type	: Practical
Total Hrs/week	: 06 hr (PR)
Course Credit	: 03

Course Objectives:

1. To produce, baker's yeast, mushroom, citric acid, ethanol and wine.
2. To prepare idli, soya, cheese and yoghurt products
3. To prepare bakery and chocolate products
4. To prepare jam, jelly chikki and extruded products

Course Content:

Preparation of biscuits, bread and cake

Preparation of chocolate

Preparation of chikki

Preparation of jam, jelly and extruded product

Fermentative production & estimation of ethanol from suitable substrate.

Production of baker's yeast

Citric acid production

Preparation of idli/tofu/ soya sauce by fermentation process

Preparation of cheese and yoghurt

Preparation of wine

Reference Book:

1. Jayaraman, J., and J. Jayaraman. Laboratory Manual in Biochemistry. New Delhi: New Age International (P) Ltd. Publishers, 2005.
2. Aneja K. R., Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom Production Technology, New Age International Limited, 2001
3. Srivastava, RP, and Sanjeev Kumar. Fruit and Vegetable Preservation: Principles and Practices. New Delhi: CBS Publishers & Distributors Pvt. Ltd., 1994
4. Srilakshmi, B. Food Science. New Delhi: New Age International Pvt, 2015.

Course Outcomes:

1. Students will able to **produce** baker's yeast, mushroom, citric acid and wine
2. Students will able to **prepare** idli and soya sauce, cheese and yoghurt
3. Students can **prepare** bakery and confectionary products
4. Students can **prepare** jam, jelly and extruded food

Elective-II (Open Elective)**Course Code : FTL-306****Course Title : Treatment and Disposal of Food Industrial Waste****Course Type : Theory****Total Hrs/week : 03 hr (TH)****Course Credit : 03****Course Objectives:**

1. To study composition, sources, permissible and health hazards of industrial wastewater pollutants
2. To study various techniques of wastewater treatment by physical chemical and biological methods
3. To study, design and operational problems of biological treatment and value addition to waste
4. Estimation of kinetic coefficients for treatment with design problem.

Prerequisites: ----Not Applicable----**Course Content:****Unit-I**

Physical, chemical and biological characteristics of food industry waste. Composition of typical industry waste. BOD /COD and characterization of effluent. Typical BOD of some food industrial effluents and their discharge limit, types and point sources of industrial pollutants and adverse effect by their discharge.

Unit-II

Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods. Process design criteria. Sanitary disposal of sludge.

Unit-III

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

Unit -IV

Activated sludge process and modified activated sludge process. Nitrification and denitrification, Aerobic lagoons, aerated aerobic lagoons, aerated facultative lagoons, Design criteria for A.S.P and stabilization ponds

Unit-V:

Trickling filters, Rotating biological contactors, design criteria and problem on RBC and trickling filter design. Byproduct recovery and value addition to the waste.

Text/ Reference Books

1. Rao, C. S. Environmental Pollution Control Engineering. New Delhi: New Age Internat., 2011
2. Arceivala Sol J., Asolekar Shyam R. Wastewater Treatment for Pollution Control and Reuse Tata McGraw-Hill Education, 2006
3. Green, John H., and Amihud Kramer. Food Processing Waste Management. Westport, Conn: AVI Pub. Co, 1979
4. Bartlett, Ronald Ernest. Wastewater Treatment: Public Health Engineering Des In Metric., Applied Science Publishers Ltd, 1971

5. Metcalf, L., H. P. Eddy, and Georg Tchobanoglous. Wastewater Engineering: Treatment, Disposal, and Reuse. New Delhi: McGraw-Hill, 2010
6. Waldron Keith W., Handbook of Waste Management and Co-Product Recovery in Food Processing, Elsevier, 2007
7. Herzka, A., and R. G. Booth. Food Industry Wastes, Disposal and Recovery. London: Applied Science Publishers, 1981
8. Bhattacharyya Bimal C., Banerjee Rintu, Environmental Biotechnology; Oxford University Press, 2007

Course Outcomes (COs):

Upon completion of the course, the students will be able to:

1. **Explore** composition of industrial effluent and health hazards of pollutants in effluent.
2. **Recognize** primary, secondary and tertiary treatment for industrial effluent treatment and design parameters.
3. **Access** principle, design and working of fixed film biological reactor efficiency.
4. **Manage** industrial effluent for recovery of biological as value addition to waste.

Elective-II (Open Elective)**Course Code : OTL-306****Course Title : Biochemistry & Biotechnology of Lipids****Course Type : Theory****Total Hrs/week : 03 hr (TH)****Course Credit : 03****Course Objectives:**

This course is designed to gain the insights about various bio-simulated reactions, pathways, and mechanisms in natural way. Also, the use of enzymes for synthetic modification and applications several fatty products will be studied. Environmental issues from biotechnological industries will also be discussed.

Prerequisites: ---Not Applicable---**Course content:****Unit-I**

Biosynthesis of fatty acids and phospholipids; Mechanism of chain elongation and desaturation of acyl chains; Regulation of lipid metabolism; Biological role of fat in human nutrition; Atherosclerosis.

Unit-II

EFA, MUFA, PUFA –Sources and biological activities in human health; Biochemical aspects of vitamins in nutrition; Toxic constituents in oilseeds and oils: Sources, structures, toxicological effects and methods of detoxification.

Unit-III

Microbial production of fats and other lipids; Biotransformation of fats and lipids using whole microbial cells; General aspects of Microbial Lipases: Sources, isolation and purification and industrial applications

Unit-IV

Enzymatic Interesterification: Chemistry, reaction in (aqueous/organic) solvent systems, immobilization of enzymes, factors affecting enzyme activity, enzyme kinetics, reactor design.

Unit-V

Structured lipids: Synthesis, analysis and applications

Genetically modified lipids: Physical, chemical and nutritional functionality modifications.

Environmental biotechnology concept: Principles in bioremediation and biological water & waste treatment.

Text/ Reference Books

1. Lehninger's Principles of Biochemistry by David L Nelson; A.L. Lehninger and Michael M. Cox, 5th edition, Worth Publishing.
2. Outline of Biochemistry by Eric.E. Conn and P.K. Stumpf, 5th edition, Wiley India.
3. Lipids: Biochemistry, Biotechnology and Health, 6th Edition by Michael I. Gurr, John L. Harwood, Keith N. Frayn, Denis J. Murphy, Robert H. Michell, Wiley-Blackwell
4. Fatty Acids in Fish Oğuz Taşbozan and Mahmut Ali Gökçe
<http://dx.doi.org/10.5772/68048>

5. Food Lipids Chemistry, Nutrition, and Biotechnology, Fourth Edition Edited Casimir C. Akoh Taylor & Francis Group

Course Outcomes (COs):

Upon completion of the course the students will be able to:

1. **Acquire** the fundamental knowledge of scholarly discourse in lipid synthesis, **recognize** the biological roles vitamins and **examine** the toxicology of lipid components.
2. **Combine** the theories and concepts of microbial lipase in industrial applications.
3. **Illustrate** the critical skills in solving the reaction kinetics and optimizing the enzymatic process.
4. **Differentiate** between structured and genetically modified lipids, and **identify** ethical issues in environmental bioremediation.

Elective-II (Open Elective)

Course Code : PTL-306
Course Title : Technology of Printing Inks
Course Type : Theory
Total Hrs/week : 03 hr (TH)
Course Credit : 03

Course Objective: The Paint Technocrat will have in depth exposure to

1. Formulation and manufacture of Printing Inks.
2. Various techniques of printing processes.
3. Different applications of printing inks

Prerequisites: ----Not Applicable----

Course Content:

Unit-I

Nature of Printing ink, Visual characteristics of inks, Major printing systems, classification and characteristics of printing inks, mechanism of ink drying, adhesive nature of printing inks, resistance properties of printing inks, physical chemistry of printing inks, rheological properties of inks principles of printing

Unit- II

Description and schematic diagram of printing processes, it's press configuration and applications e.g. Flexographic, lithographic, gravure, letterpress, planographic, screen, Inkjet printing, substrate selection principles of ink formulations, colour matching and process printing.

Unit-III

Manufacture of inks, manufacturing process, mixing equipments such as High speed impeller, butterfly mixer, Rotar and stator high speed mixer and milling equipments such as three roll mill, bead mill etc. handling, storage and manufacture of UV ink, news paper inks, modern production trends and future of inks.

Unit-IV

Inks for various substrates: paper, plastic, fabric, leather, glass and metal. Testing & Evaluation of finished ink and raw materials for ink manufacture. Inks for News paper (rotary and well offset), publication work, posters, labels, and packaging materials, heat set and quick set inks for multicolour printing.

Unit-V

Metal decorating inks, after print varnishes and lacquers, magnetic inks, ceramic inks, inks for printed circuit boards, inkjet printing, laser printing, dot-matrix printing, and other miscellaneous inks. Identification of various ink troubles and remedial measures

Text/ Reference Books

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.
2. Leach, Robert. *The printing ink manual*. Springer Science & Business Media, 2012.
3. Thompson, Robert. *Printing materials: science and technology*. Pira International, 2004.

4. Flick, Ernest W. *Printing ink and overprint varnish formulations*. William Andrew, 1999.

Course Outcomes (COs):

Upon completion of the course, the students will be able to:

1. **Understand** nature, characteristics and classification of printing inks.
2. **Recognize** principles of ink formulations and **propose** manufacturing of Inks for various substrates.
3. **Assess** press configuration and applications of printing inks.
4. **Compare** and **select** various printing processes.

Elective-II (Open Elective)

Course Code : PLL-305
Course Title : Plastics Waste Management
Course Type : Theory
Total Hrs/week : 03 hr (TH)
Course Credit : 03

Course Objective:

1. To understand the concept of plastics recycling.
2. To understand about various sources of plastics waste.
3. To understand various identification and separation method for waste plastics.
4. To learn about different recycling methods for plastics recycling.

Prerequisites: ----Not Applicable----

Course Content:**Unit- I**

Introduction, Sources of plastics waste (Industrial waste, post-consumer waste, scrap waste and nuisance waste), Plastic identification and Separation techniques – (density - float sink and froth floatation methods, optical, spectroscopic, electrostatic, sorting by melting temperature, sorting by size reduction, sorting by selective dissolution and other methods), recycling codes.

Unit- II

Plastics Waste Management - 4R's approach (reduce, reuse, recycle – mechanical and chemical, recover), recycling classification- - primary - secondary - tertiary - quaternary recycling with examples. Energy from waste – incinerators-pyrolysis, factors affecting incineration.

Unit- III

Recycling of polyolefins - PVC, PET, polystyrene, polyamides-nylon-6 and nylon-6,6, polyurethanes, mechanical process, applications of recycled materials.

Unit- IV

Recycling of rubber – comparison of thermoset and thermoplastic composites, reclaiming of rubber – fuel source – pyrolysis, Depolymerisation of scrap rubber, tyre retreading, uses of recycled rubber – asphalt and other uses.

Unit- V

Recycling of plastics by surface refurbishing - coating application, influence on plastics properties by coating, polishing of the plastics surface, commercial process. Plastics aging - environmental aging, thermal aging, weathering of plastics, mechanical degradation, chemical degradation and environmental stress cracking, wear and erosion, influence of plastic aging in recycling, energy from waste - incinerators

Text/ Reference Books

1. John Scheirs., - “Polymer Recycling Science, Technology and applications” John Wiley and Sons, 1998
2. Nabil Mustafa – “Plastics Waste Management Disposal Recycling and Reuse” Marcel Dekker Inc., First Edition 1993.

3. Steven Blow, Handbook of Rubber Technology, Galgotia Publications Pvt. Ltd., New Delhi, 1998.
4. Chandra R. and Adab A., Rubber and Plastic Waste, CBS Publishers & Distributors, New Delhi, 1994.
5. Muna Bitter, Johannes Brandup, Georg Menges “Recycling and Recovery of plastics” 1996
6. Attilio.L.Bisio, Marino Xanthos, “How to manage plastics waste: Technology and Market Opportunities” Hanser Publishers, 1994
7. Francesco La Mantia., “Handbook of Plastics Recycling” Chem Tec Publishing,2002

Course Outcomes (COs):

Upon completion of the course, the students will be able to:

1. **Identity** the sources of plastics waste and its separation methods.
2. **Choose** the sustainable approaches of plastic waste management.
3. **Propose** methods of mechanical and chemical recycling of polymers.
4. **Evaluate** recycling of plastics by surface refurbishing.

Elective-II (Open Elective)

Course Code : CHL-321

Course Title : Water Conservation and Management

Course Type : Theory

Total Hrs/week : 03 hr (TH)

Course Credit : 03

Course objectives:

The Objective of this course is to:

1. Understand current water scenarios
2. Need for water conservation and management
3. Strategies for water conservation from source to sink in different sector.

Prerequisites: ---Not Applicable---

Course Content:

Unit- I:

Introduction: water cycle, water storage, water quality. Water conservation, Current Demand of water for Domestic, Irrigation and Industries.

Current supply available, Shortage of water, water conservation process and ways to conserve water.

Unit -II:

Understanding water conservation and water quality parameter like TDS, pH, etc. Water management-water quality, controlling use and quality of water, water flow management, water quality control, testing water salinity, preserving water quality. Managing water quality in different sectors.

Unit- III:

Water conservation in agriculture-Reuse of wastewater for irrigation (Methods, Precautions), Irrigation system (Components) and Water user's participation in irrigation system management. Current Supply, utilization and shortage of water

Unit- IV:

Water conservation in construction industry: Importance of saving water in the construction industry in India, reduce and recycle water at construction sites, saving water during wall construction.

Unit- V:

Water Conservation in process industry: Water treatment, recycling, and reuse

Water saving equipment, economics of water, minimising evaporation, water audits.

Text/Reference Books

1. Irrigation Engineering-R.K. Sharma and T.K. Sharma, S.Chand & Company Ltd., New Delhi.
2. Water Resources Systems: Modeling Techniques and Analysis Vedula, S.and Mujumdar, (2005); Tata McGraw Hill, New Delhi.
3. Economics of Water Resources Planning, James, L.D., and Lee, R. R., Mc Graw Hill.
4. Agriculture and water management, P.Verma, Amiga Press Inc.
5. Industrial water treatment process technology, Parimal Pal, Elsevier Science.

Course Outcomes (COs):

Upon completion of the course, the students will be able to:

1. **Understand** the importance of water conservation and management in different sectors.
2. **Identify** the thrust area for water conservation
3. **Develop** management strategies to achieve effective water conservation.
4. **Implement** the developed strategies effectively.

Elective-III (Professional Core Elective)

Course Code	: FTL-307
Course Title	: Food Processing-I
Course Type	: Theory
Total Hrs/week	: 03 hr (TH)
Course Credit	: 03

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 process technology for baked and confectionery products To study process technology for preparing convenience and fast foods, Snack foods and special foods, IM foods and instant foods

Course Content**Unit-I**

Process Technology of cereals grains: Types, grading and quality. Milling technology of wheat, rice and wet milling of corn. Isolation and processing of starch, Byproducts of milling industry. Malting of cereal.

Unit-II

Classification, types and Milling technology of legumes and oil seeds, extraction, refining & hydrogenation of oil. Manufacture of margarine.

Unit-III

Role of ingredients and chemistry of bakery products, Rheology of dough, changes during dough formation. Manufacturing of bread, biscuit, cookies, cracker and cakes. Bread and cake improvers. Quality control in baked goods

Unit IV

Manufacturing of breakfast cereals, puffed cereals, extrusion process and extruded products, baked snack foods. Fast foods & convenience foods. Speciality foods: weaning & baby foods, IM foods, & instant food.

Unit-V

History of Cocoa beans and origin and quality selection. Technology of cocoa processing. Manufacturing of dark and white chocolate & milk chocolate. Confectionary technology: manufacturing of hard-boiled candies, caramel, chikki.

Text Books

1. Kent-Jones, D. W., and A. J. Amos. Modern Cereal Chemistry. Liverpool: the Northern Publishing, 1967
2. Matz, Samuel A. Snack Food Technology. Place of publication not identified: Springer, 2013
3. Daniel Albert R., Bakery Materials and Methods: A Book for Every Baker and Confectioner, Maclaren, 1963.

4. Sultan, William J. Practical Baking, 1976.
5. Harper, Judson M. Extrusion of Foods. Boca Raton: CRC Press, 2019.
6. Lees R., Sugar Confectionery and Chocolate Manufacture, Springer Science & Business Media, 2012

Reference Books

1. Sinha, R. N., and W. E. Muir. Grain Storage: Part of a System. Westport, CT: Avi, 1973.
2. Kent, Norman Leslie. Technology of Cereals with Special Reference to Wheat. Oxford: Pergamon Press, 1978.
3. Matz, Samuel A. Cereal Technology. McAllen: Pan-Tech International, Inc., 1999.
4. Bywaters, H. W. Modern Methods of Cocoa and Chocolate Manufacture. London: J. & A. Churchill, 1930.
5. Pomeranz, Yeshajahu. Wheat: Chemistry and Technology. St. Paul, MN, 1988
6. Fritsch, J., P. GrosPierre, and Charles M. Stern. The Manufacture of Biscuits, Cakes, and Wafers. London: Sir I. Pitman & Sons, 1932.
7. Vaclavik, Vickie, and Elizabeth W. Christian. Essentials of Food Science. New York: Chapman and Hall, 1998

Course Outcomes:

1. The students will be able to **interpret** the milling technology of wheat, rice, corn, malting of grains and byproducts of milling.
2. The students can **describe** milling of legumes and hydrogenation of crude oil.
3. Student can **explore** baked products and various chocolates.
4. Student can **outline** of special foods, Convenience, fast food, Snack foods, instant mixes, hard boiled candies

Elective-III (Professional Core Elective)**Course Code : FTL-308****Course Title : Fruits and Vegetable Processing Technology****Course Type : Theory****Total Hrs/week : 03 hr (TH)****Course Credit : 03****Course Objectives:**

1. To study quality assessment of fruit & vegetables, and their post-harvest technology
2. To study outline of fruit and vegetable processing for finished product and their machines
3. To study process technology for Fruit and vegetable products: concentrate, puree, jam, jelly, marmalade, preserves, candid fruits, pickles, chutneys, RTS, and carbonated beverages
4. To understand FSSAI, international standards WHO, FAO, Codex Alimentarius Specification of various Fruit and vegetable products of Fruit and vegetable products, good manufacturing practices (GMP).

Course Content:**Unit I:**

Quality assessment of fruit & vegetables. Physiology of plant tissue, Plant pigments. Effect of processing on colour and texture, Post-harvest technology of fruit and vegetables.

Unit II:

Instruments for Fruits and vegetable processing; washing, grading, peeling, extraction, thermal processing and canning of food products.

Unit III:

Process technology for concentrate, puree, jam, jelly, marmalade, candid fruits, pickles, chutneys, RTS, and carbonated beverages and their packaging.

Unit IV:

Dehydrated and speciality products and by-products of fruits and vegetables. Tomato processing, honey and sugar processing.

Unit V:

Specification of various fruits and vegetable products, FSSAI, international standards WHO, FAO, Codex Alimentarius standards for fruits and vegetables processed products, good manufacturing practices (GMP).

Textbooks:

1. Girdharilal, G. S. Siddappa, and G. L. Tandon. Preservation of Fruits and Vegetables. New Delhi: Publications and Information Division, Indian Council of Agricultural Research, 2011
2. Desrosier, Norman W., Technology of Food Preservation.: ED-TECH, 2018.
3. Tressler, Donald Kiteley, Van Arsdell Wallace B., Michael J. Copley, and Willis Raymond Woolrich. The Freezing Preservation of Foods. Westport (Conn.): Avi Publishing, 1968.

Reference Books:

1. Charm, Stanley E. Fundamentals of Food Engineering. Westport, CT: Avi publishing, 1981.
2. Karel, Marcus. Physical Principles of Food Preservation. New York: Marcel Dekker, 2003.
3. Desrosier Norman W., Rosenstock Henry M. Radiation technology in food, agriculture, and biology Avi Pub. Co., 1960
4. Bennet, Gregory S. Modern Technology on Food Preservation. Delhi, India: Asia Pacific Business Press, 2008

Course Outcomes:

1. Students will be able to **define** quality aspects and post-harvest handling of fruit & vegetables.
2. Students will be able to **recognize** and use various unit operations and equipment's fruit & vegetables processing.
3. Students can **design** different Fruits and vegetables processed products.
4. Students will be able to **express and apply** various rules and regulations like FSSAI, international standards WHO, FAO, Codex Alimentarius Specification for fruits and vegetables.