# Syllabus of Third Year

## B. Tech. (Oil, Fats & Waxes 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. (Oil, Fats & Waxes 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 & Project Management | 03 | - | 03 | - | - | 03 |
| OTC-301 | Refining of Oils & Fats | 03 | - | 03 | 03 | 1.5 | 4.5 |
| OTC-302 | Quality Control Techniques in Oils & Fats | 03 | - | 03 | 03 | 1.5 | 4.5 |
| 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 |
| OTL-303 | Technology of Fat Splitting & soaps | 03 | - | 03 | - | - | 03 |
| OTP-304 | Processing and Analysis of Soaps and High Fat allied Products | - | - | - | 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)**

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

**Elective II (Open Elective)**

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

**Elective III (Professional Core Elective)**

OTL-307 High Fat Products and Industrial Hydrogenation
OTL-308 Technology of Oleochemicals & Environmental Aspects

**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, MaCabe-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 maximum 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 seperation 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.

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|---|---|
| **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.

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|---|---|
| **Course Code** | **: CHL-312** |
| **Course Title** | **: Process Design & 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 & amp; M.S. Mahajan *Industrial Organization & amp; 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. Drydens*Outlines of Chemical Process Technology*, Third Edition, 1997
6. D.B.Dhone*Plant Utilities*NiraliPrakashan, 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.

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| **Course Code** | **: OTC-301** |
| **Course Title** | **: Refining of Oils and Fats** |
| **Course Type** | **: Theory** |
| **Total Hrs/week** | **: 03 hr (TH)** |
| **Course Credit** | **: 03** |

**Course Objectives:**
The course is prepared with intent of catering the important conventional techniques for refining of crude vegetable oils. Also, current and conceptual advanced methods of refining will be introduced. Awareness about the treatment of effluent from refining plant for environment safety will be discussed.

**Prerequisites:**

Post Harvest Technology of Oil Bearing Materials (OTC-202)
Material and energy Balances Computations (CHL-206)
Mechanical Operations (CHC-207)

**Course content:**

**Unit- I**
Minor components of crude fatty oils, Dewaxing and De-sliming of oils: Principles & Methods, Degumming of oils, Lecithin recovery & its Utilization.

**Unit -II**
Alkali De-acidification of oils: Batch and continuous methods, Refining loss & Refining efficiency concept, Effect of operating variables on chemical refining, De-acidification by Zenith process, Soapstock Processing, Miscella refining, Physical refining.

**Unit- III**
Bleaching of oils: Different types of coloring matters in oils, Theory and principle of adsorptive beaching, Adsorptive bleaching agents, Bleaching process description, Recovery of oil from bleaching byproduct.

**Unit-IV**
Deodorization of oils: Flavor and odor releasing substances, deodorization Principle, Influence of various parameters, Deodorization equipment, Deodorizer distillate Utilization.

**Unit-V**
Advance techniques of refining: Enzymatic degumming, Bio-deacidification, Membrane degumming, Membrane deacidification.
Treatment of effluents from refining plant, Energy conservation in oil processing industries.

**Text/ Reference Books**


1. Bailey's Industrial Oil and Fat Products, Volume 5, Sixth Edition Edible Oil and Fat Products: Processing Technologies Edited by Fereidoon Shahidi, A Wiley-Interscience Publication, JOHN WILEY & SONS, New York.
2. Gupta, M. K. 2008. Practical guide to vegetable oil processing. AOCS Press, Urbana, Illinois.
3. M.M Chakrabarty. Chemistry and Technology of Oils and Fats. Allied Publishers Pvt. Ltd. New Delhi.

4. List, G. 2009. Bleaching and Purifying Fats and Oils Theory and Practice. AOCS Press.
5. W. Hamm, R. J. Hamilton, G. Calliauw 2013. Edible Oil Processing, Second edition, John Wiley & Sons, Ltd, UK
6. Dijkstra, A. J. (2017). About water degumming and the hydration of non-hydratable phosphatides. *European journal of lipid science and technology*, *119*(9), 1600496.
7. Pandey, R. A., Sanyal, P. B., Chattopadhyay, N., & Kaul, S. N. (2003). Treatment and reuse of wastes of a vegetable oil refinery. *Resources, Conservation and Recycling*, *37*(2), 101-117.
8. Dumont, M. J., & Narine, S. S. (2007). Soapstock and deodorizer distillates from North American vegetable oils: Review on their characterization, extraction and utilization. *Food Research International*, *40*(8), 957-974.
9. Bhosle, B. M., & Subramanian, R. (2005). New approaches in deacidification of edible oils—a review. *Journal of Food Engineering*, *69*(4), 481-494.
10. de Morais Coutinho, C., Chiu, M. C., Basso, R. C., Ribeiro, A. P. B., Gonçalves, L. A. G., & Viotto, L. A. (2009). State of art of the application of membrane technology to vegetable oils: A review. *Food Research International*, *42*(5-6), 536-550.
11. Gunawan, S., & Ju, Y. H. (2009). Vegetable oil deodorizer distillate: characterization, utilization and analysis. *Separation & Purification Reviews*, *38*(3), 207-241.

**Course Outcomes (COs):**

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

1. **Evaluate and compare** the applicability of different stages of refining.
2. **Identify** and **propose** the different core chemical engineering operations in designing of refining units.
3. **Develop** the technical knowledge of other discipline contributing as green technological applications into refining process.
4. **Illustrate** the oil industry effluent treatment methods, energy conservation techniques and the environmental issues.

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| **Course Code** | **: OTC-301** |
| **Course Title** | **: Refining of Oils and Fats** |
| **Course Type** | **: Practical** |
| **Total Hrs/week** | **: 03 hr (PR)** |
| **Course Credit** | **: 1.5** |

**Course Objectives:**
The course provides the opportunity to the students to integrate many of the skills and principles they learned from curriculum in understanding the different stages of refining process. It also makes students work productively and enhance their problem solving skills.

**Prerequisites:**

Chemistry and Technology of Lipids (OTC-201)
Post Harvest Technology of Oil Bearing Materials (OTC-202)
Material and energy Balances Computations (CHL-206)
Mechanical Operations (CHC-207)

**Experiments:**

1. Laboratory degumming and dewaxing of crude oils.
2. Laboratory alkali refining of crude oils using aqueous-alkali, alcoholic alkali and Miscella-alkali deacidification.
3. Bleaching of crude oils using different adsorbents.
4. Analysis of fuller's earth and activated carbon.
5. Soapstock acidulation to produce acid oil.
6. Determination of unsaponifiable matter in oil and fat.
7. Treatment of phospholipids gums for Lecithin recovery and its purification method.
8. Treatment of spent bleaching for oil recovery.
9. Analysis of processed oils and other oil products for-
   (a) Soap content (b) Phosphatides content
   (c) Iron content (d) Wax content

**Reference Books**

1. Departmental Practical Manual.

**Course Outcomes (COs):**
Upon completion of the course, students will be able to:

1. **Demonstrate** the degumming, neutralization, dewaxing methods in laboratory to test the hypothetical knowledge.
2. **Design** and **conduct** the experiment to analyze the efficacy of activated carbon in removal of coloring matter from crude oil samples.
3. **Develop** the lab scale deodorization process for removal of foul odors from crude oil.
4. **Exhibit** the team work and problem solving skills.

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| **Course Code** | **: OTC-302** |
| **Course Title** | **: Quality Control Techniques in Oils & Fats** |
| **Course Type** | **: Theory** |
| **Total Hrs/week** | **: 03 hr (TH)** |
| **Course Credit** | **: 03** |

**Course Objectives:**
This course is designed to give a thorough knowledge of different methods to analyze and control the quality of oils, soaps and detergents. Knowledge about different modern analytical equipments is also to be given.

**Prerequisites:**

Chemistry and Technology of Lipids (OTC-201)
Post Harvest Technology of Oil Bearing Materials (OTC-202)
Material and energy Balances Computations (CHL-206)
Mechanical Operations (CHC-207)

**Course Content:**

**Unit -I**
Significance of Quality Control; Techniques of separation of glycerides and fatty acids: Liquid - liquid extraction; fractional distillation; low temperature crystallization; separation as lead and lithium soaps**,** urea complexes etc; Dilatometry of fats: Theory and Practice, Special dilatometric investigation; Determination of colour of crude and refined oils.

**Unit -II**
Application of chromatographic techniques in the quality control and quality assurance of oils, fats and related products ; History, theoretical developments and various techniques e.g., thin layer chromatography, column chromatography, gas-liquid chromatography, HPLC and Super critical Chromatography; their principles, practices and specific applications in the analysis of oils and allied products.

**Unit –III**
Spectroscopy and its application; Ultra-violet, visible, infrared and near infrared spectroscopy techniques: principles, practices and application to the analysis of oils and allied products. Nuclear magnetic resonance spectroscopy: principle, high resolution spectra of fats and fatty acids, adsorption of special groups, analysis of spectra and quantitative applications.

**Unit –IV**
Specific quality control methods viz. nickel content of hydrogenated oils; iron, sulphur and phosphatide content of crude and refined vegetable oils; wax content of vegetable oils; Testing of DOC and Oil beyond conventional testing for the purpose of export. Polymorphism of fats and fatty acids. Application of TLC-FID analyzer, GC-MS, SFC-GC, LC-MS, Induced Coupled Plasma-MS in the analysis of oils and fats.

**Unit –V**
Quality assurance; Definition and its scope; Agmark, Bureau of Indian Standards ,ISI specifications and procedures IUPAC, ASTM and AOCS specifications and methods for the analysis of oils and fats. Procedures and norms for the ISO certification for oil, oleo chemicals and allied industries.

**Text/ Reference Books**


1. Manual of Methods of Analysis of Foods, Oils and Fats. Food Safety and Standards Authority of India, 2015
2. Laboratory Handbook for Oil and Fat Analysts. L. V. Cocks and C. Van Rede
3. Standard Methods for the Analysis of Oils, Fats and Derivatives. C. Paquot, Pergammon Press, 6th Edition, 2013
4. Chemistry and Technology of Oils and Fats. M.M Chakrabarty, Allied Publishers Pvt. Ltd. New Delhi
5. Fats and Oils Formulating and Processing for Applications, 3rd Edition Richard D.O. Brien, 2009


**Course Outcomes (COs):**

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

1. **Employ** the thorough knowledge of basic techniques like Chromatography, Spectroscopy, Dilatometry, Hyphenisation etc and **identify** the application and utility of these characterization techniques in Industrial production and Research.
2. **Appraise** the procedure and applications of International and National norms, and Bodies for Quality Assurance like ISO, BIS, AOCS, and IUPAC and ASTM with due emphasis on health and Environment issues.
3. **Analyze** the vital information on Quality assurance techniques for up gradation of product and treatment of byproducts and effluents.
4. **Plan** the testing of DOC and oils beyond conventional norms for the purpose of export.

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| **Course Code** | **: OTC-302** |
| **Course Title** | **: Quality Control Techniques in Oils & Fats** |
| **Course Type** | **: Practical** |
| **Total Hrs/week** | **: 03 hr (PR)** |
| **Course Credit** | **: 1.5** |

**Course Objectives:**
This course is designed to give complete at hand knowledge and practice for quality control of oils, fats, and allied products; along with the analytical equipments requirements for the same.

**Pre-requisites:**
Chemistry and Technology of Lipids (OTC-201)
Post Harvest Technology of Oil Bearing Materials (OTC-202)

**Experiments:**
1. Separation of saturated and unsaturated fatty acids by low temperature crystallization, urea adducts method.
2. Determination of fatty acid composition of oils and fats by GLC.
3. Determination of glyceride composition/distribution by following techniques.
4. Solvent crystallization, Lipase hydrolysis, GLC, HPLC etc.
5. Determination of conjugation by UV spectrophotometer.
6. Analysis of oilseeds and oil bearing materials by NIR analyzer.
7. Determination of trans-fatty acid content of hydrogenated oils by IR Spectrophotometer.
8. Dilatometric measurements.
9. Analysis of toxic constituents present in oilseeds.
10. Determination of phosphorus and metal content of oils and fats

**Reference Books**
1. Departmental Practical Manual.

**Course Outcomes (COs):**
Upon completion of the course, students will be able to:
1. **Apply** the basic Science, Engineering, and Oil Technology principles for the analysis during production and quality control of the end product.
2. **Choose** the appropriate analysis technique for the characterization of products like oil bearing materials, oil, and target product and by products.
3. **Ascertain** the level of calibration and least count of the instruments as per the current consumer requirement and environmental laws.
4. **Conclude** the controlling parameters for different processes of manufacturing on the basis of studied QC techniques.

## 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 : 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 s**helf life of food packaged.
4. **State** packaging of, soft drink, alcoholic beverages, and frozen food.

## 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, $CaCO_3$, 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 Fluro 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, 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, 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 flexbility 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, 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----

**Course Content:**

**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, $CaCO_3$, $CaSO_4$.

**UINT-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 analysingNanomaterials: 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, Wiely-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, 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.

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|---|---|
| **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, 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.

**SIXTH SEMESTER**

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| **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, 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.

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| **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, 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.

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| **Course Code** | **: OTL-303** |
| **Course Title** | **: Technology of Fat Splitting & Soaps** |
| **Course Type** | **: Theory** |
| **Total Hrs/week** | **: 03 hr (TH)** |
| **Course Credit** | **: 03** |

**Course Objectives:**
This course exhaustively covers the methods of fat splitting to obtain fatty acids, and treatment methodology for recovery of glycerin as by-product. Also, different soap making processes are introduced to orient the students to industrial framework. Application of the various chemical engineering operations in these processes is included.

**Prerequisites:**

Chemistry and Technology of Lipids (OTC-201)
Heat Transfer (CHC-203)
Mechanical Operations (CHC-207)
Refining of oils and fats (OTC-301)

**Course content:**

**Unit – I**
Fat Splitting: Chemistry & Degree of fat splitting; Effect of temperature, pressure, catalyst and ratio of reactants in fat splitting.
Plants and processes of fat splitting: Twitchell process, Enzymatic fat splitting, High-pressure batch and continuous splitting.
Fatty acid separation: Fractional Distillation, Solvent crystallization.

**Unit– II**
Sources of Glycerine: Natural source & Chemical synthesis of glycerine
Glycerine recovery: Pretreatment of sweet waters and spent lye, Evaporation (Calendria type single & double effect evaporator), Refining of glycerine (Distillation, Residue recovery & disposal, Bleaching)
Grades of glycerin: Soap lye crude glycerine, Hydrolyser crude glycerine, USP glycerine, CP glycerine, Dynamite glycerine, High gravity glycerine
Applications of glycerine

**Unit– III**
Soap: Chemistry, classification and cleaning action of soap
Selection of oils & Fats in soap making: INS factor, Solubility ratio, Hardness number; Pretreatment and upgradation; Fat blend formulation
Soap making techniques: Cold, semi-boiled & full boiled method; Jet saponification (Cross & Concentric Jet) method; Saponification loop

**Unit– IV**
Selection and functions of non-fatty materials in soap making: Builders, Fillers, Foaming agents, Bacteriostatic agents, Clarifiers, Coloring agents, Perfumes, Fixatives, Preservatives, Optical brighteners, Super-fatting agents
Continuous soap making processes: Sharples, Delaval, and Monsavon
Soaps from fatty acids: Advantages & Disadvantages; Mazzoni process
Soap finishing line: Drying, Milling, Plodding

**Unit– V**

Modern plants of toilet soap production: Colgate-Palmolive & Lever-Rexona Process
Specialty soaps: Transparent soap, Carbolic soap, Floating Soap, Soft soap and Liquid soap
Analysis of soaps: Total fatty matter, Free caustic alkali
Soap powders: Spray-chilling and spray-drying
Packaging of soaps

**Text/ Reference Books**


1. M.M Chakrabarty. Chemistry and Technology of Oils and Fats. Allied Publishers Pvt. Ltd. New Delhi.
2. NIIR Board. The Complete Technology Book on Soaps (2nd Revised Edition)
3. Parasuram K. S. (2002) Soaps and Detergents. Tata Macgraw Hill. (ISBN 007-462324-9)
4. Spitz, L. (2016). Soap Manufacturing Technology: Second Edition.


**Course Outcomes (COs):**

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

1. **Recognize** & **analyze** the process operations in fat splitting & glycerine recovery.
2. **Propose** the core chemical engineering techniques such as distillation, fractionation, crystallization, autoclave operations, evaporation, blending, chilling and drying etc during the complete continuous industrial production of finished soap.
3. **Compare** the selection criteria of fatty and non-fatty raw materials and **formulate** the specialty soaps.
4. **Assemble** the machineries for typical soap line production and **analyze** the finished soap for quality.

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| **Course Code** | **: OTP-304** |
| **Course Title** | **: Processing and Analysis of Soaps & High Fat Allied Products** |
| **Course Type** | **: Practical** |
| **Total Hrs/week** | **: 06 hr (PR)** |
| **Course Credit** | **: 03** |

**Course Objectives:**
This course provides hand-on demonstrations for soap based product preparations. Importance of analysis of soap product for different properties is to be understood. Also, high fat allied experimentation and quality evaluation is to be performed.

**Prerequisites:**
Chemistry and Technology of Lipids (OTC-201)
Mechanical Operations (CHC-207)
Quality Control Techniques in Oils & Fats (OTC-302)

**Experiments:**
1. Laboratory Preparations of -
   a) Toilet/laundry soap b) Metallic soap
   c) Transparent Soap d) Medicated Soap
   e) Shaving Soap f) Liquid Soap (Shampoo)
   g) Turkey Red oil
2. Analysis of household and toilet soaps for
   a) Active matter b) Moisture and volatile matter content
   c) Free alkali d) Total alkali
   e) Total fatty matter f) Chloride content
   g) Glycerol content h) Alcohol soluble & insoluble
3. Treatment and recovery of glycerol from spent soap lye
4. Laboratory hydrogenation of oils
5. Analysis of activated carbon and nickel catalyst
6. Inter-esterification of oils
7. Quality evaluation of Margarine for Peroxide value, Free fatty acids, Moisture and SFI.

**Reference Books**
1. Departmental Practical Manual.

**Course Outcomes (COs):**
Upon completion of the course, students will be able to:
1. **Demonstrate** the laboratory preparations of specialty soaps and **analyze** them for quality assurance.
2. **Apply** the technical details in glycerol recovery, hydrogenation and inter-esterification experimentations in lab setup.
3. **Evaluate** the quality of margarine sample and **interpret** the analytical results.
4. **Organize** the experimental runs in safer manner, **perform** the experimental computing and **summarize** the results.

**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 bio-technological 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**


4. Lehninger's Principles of Biochemistry by David L Nelson; A.L.Lehninger and Michael M. Cox, 5th edition, Worth Publishing.
5. Outline of Biochemistry by Eric.E. Conn and P.K. Stumpf, 5thedition, Wiley India.
6. 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

7. Fatty Acids in Fish Oğuz Taşbozan and Mahmut Ali Gökçe http://dx.doi.org/10.5772/68048
8. Food Lipids Chemistry, Nutrition, and Biotechnology, Fourth Edition Edited Casimir C. Akoh Taylor & Francis Group

**Course Outcomes (COs):**

Upon completion of the course, 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 : 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., AsolekarShyam 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, 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 : PTL-306**

**Course Title : Technology of Printing Inks**

**Course Type : Theory**

**Total Hrs/week : 03 hr (TH)**

**Course Credit : 03**

**Course Objectives:** 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, 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 Objectives:**

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, 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 : OTL-307**

**Course Title : High Fat Products and Industrial Hydrogenation**

**Course Type : Theory**

**Total Hrs/week : 03 hr (TH)**

**Course Credit : 03**

**Course Objectives:**

The objective of this course is to apply the chemical engineering principles of heat and mass transfer and the mechanical engineering phenomenon of stirring and mixing of multiphase system, to get solid fat. The principle, process and application of the modification of vegetable oils are also to be understood.

**Pre-requisites:**

Chemistry and Technology of Lipids (OTC-201)
Quality Control Techniques in Oils & Fats (OTC-302)

**Course Content:**

**Unit – I**

Processing plants and equipments for hard oils; industrial applications of hard oils e.g. soaps, lubricating greases etc.; Manufacture techniques and process plants for shortening, margarine, bakery and confectionery fats; Selection of fats and their blends for shortening and margarine; different types of plastic shortening agents; shortening and cocoa butter substitute by interesterification; chilling equipments for bakery shortening; Selection of additives and their requirements.

**Unit – II**

Cooking oils, Salad oils and dressings: Natural and processed salad and cooking oils; Additives for salad and cooking oils; Stability and quality evaluation of salad and cooking oils; Nutrition-oriented applications of cooking salad oils Hydrogenation of oils: Theory and importance of hydrogenation, kinetics of reaction, operating variables and their effect on rate of hydrogenation, selectivity and isomer formation.

**Unit – III**

Hydrogenation catalysts: Theory of catalyst structure, catalyst poisons and promoters, properties of catalysts e.g. porosity, selectivity, activity and other properties, different types of catalysts employed for hydrogenation of oils and fats, methods of catalyst manufacture, regeneration of nickel catalyst. Manufacture of hydrogen: Various methods of production and its purification for hydrogenation purposes, storage of hydrogen and handling of by-products of hydrogen production.

**Unit – IV**

Commercial plants and processes employed for hydrogenation of oils and fats; Design of hydrogenating vessels; , batch and continuous methods, loop reactors, helical screw reactors High-pressure hydrogenation for production of fatty alcohol; conjugated hydrogenation; Hydrogenation of fatty acids: importance of operating variable and feed stock purity.

**Unit – V**

Quality control of modified fats, frying and stability characteristics, nutrition & health aspects, Trans-unsaturated fatty acids and polyunsaturated fatty acids in nutrition and health., Diacylglycerols as low calorie fats,. Energy conservation and safety aspects in hydrogenation process.

**Text/ Reference Books**


1. Bailey's Industrial Oil and Fat Products, Volume 5, 6th Edition, Edited by Fereidoon Shahidi, A Wiley- Interscience Publication, John Wiley & Sons, New York.
2. Gupta, M. K., Practical guide to vegetable oil processing. AOCS Press, 2008 Urbana, Illinois.
3. M.M Chakrabarty. Chemistry and Technology of Oils and Fats. Allied Publishers Pvt. Ltd. New Delhi.
4. Fats and oils, Formulating and Processing for Applications, 3rd Edition,2009, Richard D.O. Brien.
5. Fats and Oils Handbook, Michael Bockisch, 1st Edition, 1998, AOCS Press


**Course Outcomes (COs):**

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

1. **Analyze** the principle behind manufacturing hard oils for edible and other commercial applications.
2. **Review** the commercial processes of Batch and continuous type hydrogenation plants supplied by different manufacturers along with operating parameters in detail.
3. **Outline** the energy Conservation and Safety aspects of the manufacturing processes.
4. **Apply** the Chemical Engineering and Mechanical Engineering principles to suggest process conditions for smooth, efficient, and safe running of the hydrogenation plant.

**Elective-III (Professional Core Elective)**

**Course Code : OTL-308**
**Course Title : Technology of Oleochemicals & Environmental Aspects**
**Course Type : Theory**
**Total Hrs/week : 03 hr (TH)**
**Course Credit : 03**

**Course Objectives:**
This course comply the modification methodologies of oil/fat and production of industrially engineered Oleochemicals. Also, on completion of the course students will have an understanding of solid, liquid & gaseous pollution caused by industries, their environmental impact and various methods of industrial pollution prevention and control.

**Pre-requisites:**
Chemistry and Technology of Lipids (OTC-201)
Quality Control Techniques in Oils & Fats (OTC-302)

**Course Content:**

**Unit-I**
Transformations of oils: Polymerization, Pyrolysis, Epoxidation, Ozonolysis, Halogenation
Fatty alcohols and amines: Production and their utilization
Sulphated and sulphurised oils: Production, properties and applications

**Unit-II**
Castor oil derivatives: DCO, Sebacic acid, Undecenoic acid, Heptaldehyde, 2-Octanol, Ethoxylated castor oil, Hydrogenated castor oil
Chemical synthesis of fatty acid derivatives: Erucic acid, Brassylic acid, Azelaic acid

**Unit-III**
Modified and novel fatty acids; Polymorphism of fats and fatty acids
Advances in shortening and margarine processing
Engineering bio-fuels from oils
Oil based additives for food, printing ink and packaging industry

**Unit-IV**
Waste Management: Pollution prevention, ISO 14000, Waste audit, Quality management systems, Regulatory acts for air, water & solid pollution control.

**Unit-V**
Solid waste treatment: Spent earth, catalyst, boiler ash treatment and disposal
Liquid waste treatment: Pretreatment methods, biological oxidation, ion exchange system
Gas waste treatment: Mechanical collectors, electrostatic precipitator, filters, wet scrubbers, vapour phase system

**Text/ Reference Books**


1. Richard D. O'Brien "Fats and Oils: Formulating and Processing for Applications" 3rd Edition (2008) CRC Press
2. Moghis Ahmad "Fatty Acids: Chemistry, Synthesis, and Applications" 1st Edition. Academic Press and AOCS Press.
3. Robert Selby Morrell, H. R. Wood "The Chemistry of Drying Oils" E. Benn limited.

4. Ian P. Freeman, Sergey M. Melnikov (2015) “Margarines” https://doi.org/10.1002/14356007.a16_145.pub2
5. International Castor Oil Association (1992) “The Chemistry of Castor Oil and Its Derivatives and Their Applications”
6. Ram Chandra (2015) “Environmental Waste Management” CRC Press Woodard &amp, Curran, Inc. “Industrial Waste Treatment Handbook” 2nd Edition (2006) Butterworth-Heinemann

**Course Outcomes (COs):**

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

1. **Illustrate** the various transformations reactions for development of oleochemicals from fatty oils/fats.
2. **Propose** the different chemical synthesis methods and applications of fatty derivatives.
3. **Recognize** the current scientific literature of novel fatty acids, their polymorphism and processing of shortening and margarine.
4. **Examine** the environmental regulatory legislations and standards, and **propose** different methodologies and unit operations involved in industrial waste treatment.