Enclosure - I

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC19	Core-11 Principles of Chemical Engineering-I	03 hrs/wk	03 Credits

Objectives:

1. To understand the dynamics of fluid flow.
2. To apply basic principles of heat transfer to industrial equipments.
3. To classify equipments used in size reduction.

Unit-I: Fluid Mechanics **(09 hrs)**

- Introduction and terminologies,
- Classification of fluids,
- Properties of fluids,
- Viscosity and its measurement,
- Pressure and its measuring device,
- Flow rate and types of flow rate,
- Mass and energy balance over the fluid flow system :
  - Continuity equation and
  - Bernoulli's equation,
- Reynold's experiment.
- Major and minor energy losses in flowing fluid.
- Flow measurement in closed channels:
  - Venturimeter,
  - Orificemeter,
  - Nozzlemeter,
  - Pitot tube,
  - Rotameter.
- Flow measurement in open channels:
  - Rectangular notch,
  - Triangular notch.

Unit-II: Heat Transfer: Conduction **(06 hrs)**

- Introduction and terminologies,
- Units and dimensions,
- Modes of heat transfer,
- One dimensional steady state conduction,
- Fourier's law of heat conduction,
- Thermal conductivity,
- Thermal insulation,
- Heat flow through rectangular slab,
- Heat flow through cylinder,
- Heat flow through sphere,
- Compound resistance in series and parallel,

- Numericals based on heat conduction,

Unit-III: Heat Transfer: Convection (06hrs)

- Introduction,
- Natural convection and forced convection,
- Individual and Overall heat transfer coefficient,
- Fouling factor,
- Resistance form of overall coefficient,
- Mass and energy balance:
    - Heat exchanger,
    - Evaporators,
    - Crystallizers,
    - Distillation column.
- Designing a distillation column:
    - McCabe Thiele method for calculation of number of plates,
    - Equation of q-line,
    - Reflux ratio.

Unit-IV: Size Reduction (09 hrs)

- Fundamentals of size reduction,
- Units and dimensions involved in size reduction,
- Importance of size reduction,
- Specific properties of solids for size reduction,
- Crushing efficiency, mechanical efficiency,
- Principles of size reduction,
- Classification of size reduction equipments,
- Introduction to screening operations,
- Differential analysis and Cumulative analysis.

Unit-V: Size Reduction Equipments (06 hrs)

Principle, Construction, Working, Advantages and Disadvantages of:

- Jaw Crusher
- Roll Crusher
- Ball Mill
- Hammer mill.

Text Books:

1. K.A. Gavhane, (2009), Unit Operations-I, Nirali Publications, ISBN: 978-81-96396—11-4
2. K.A. Gavhane, (2009), Unit Operations-II, Nirali Publications, ISBN: 978-81-96396—12-1
3. RK Bansal, (2006), A Textbook of Fluid Mechanics, Laxmi Publication (P) Ltd, ISBN: 8170088135, 9788170088134

Reference Books:

1. SP Sukhatme, (2005), Heat Transfer, Universities Press (India) Private Limited, ISBN:81-7371-544-0
2. AK Mohanty, (2006), Fluid Mechanics, Prentice Hall of India Private Limited, ISBN: 81-203-0894-8

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC20	Core-12 Heavy Chemicals	03 hrs/wk	03 Credits

Objectives:

1. Apply knowledge of heavy chemicals by manufacturing heavy chemicals used in chemical Industries.
2. Analyze the practical skill by producing metal based catalyst used in chemical reaction to alter rate of reaction.
3. Obtain valuable products used in various plastic Industries as raw materials.

Unit-I: Heavy Chemicals- Nitrogen & Chlor-alkali (09 hrs)

- Introduction to Heavy Chemicals
- Synthetic Nitrogen products: Ammonia, ammonium nitrate and Ammonium sulphate, Nitric acid. Chlor-alkali industrial products: Caustic soda, Chlorine.

Unit-II: Phosphorous & Carbon (09 hrs)

- Phosphorous chemicals : Phosphorus, Phosphoric acid, Ammonium phosphate, Super
  Phosphate, Triple Super Phosphate.
- Industrial carbon: Carbon black, manufacture of graphite and carbon. Lime, Gypsum, Silicon, Calcium carbide, Silicon carbide.

Unit-III: Halogen & Industrial Catalyst (10 hrs)

- Fluorine, Bromine, Iodine, Hydrobromic acid, Inter halogen compounds. Sodium chloride, Sodium Sulphate, Sodium Sulphite, Sodium thiosulphate, Borax, Boric acid.
- Industrial Catalysts – Raney nickel, other forms of Nickel, Palladium, Copper

Chromate, vanadium, Platinum based catalyst. Titanium tetrachloride, Titanium dioxide

Unit-IV: Important Heavy Chemicals-1 (10 hrs)

- Manufacture of the following with reference to raw materials, flow chart, properties and uses; Fischer – Tropsch synthesis Examples; Application, Uses and Manufacturing of Zeolites.
- Prop-4 –butanediol, Acrylates, Sorbitol ,Propyl alcohol, Glycerol

.

Unit-V: Important Heavy Chemicals-2 (10 hrs)

- Manufacture of the following with reference to raw materials, flow chart, properties and

  uses; Vinyl esters, Vinyl chloride. Pyridine, Phenol, Acetone, Resorcinol, Phthalic anhydride, Melamine, Formaldehyde.

Text Books:

1. Rao & M Gopala,1997, Dryden's Outlines Of Chemical Technology, East-West Press, 8185938792
2. Harold A. Wittcoff, Bryan G. Reuben & Jeffery S. Plotkin, 2012, Industrial Organic Chemicals, 3rd Edition, Wiley, 978-0-470-53743-5

Reference Books:

1. George T. Austin,2017,Shreve's Chemical Process Industries, McGraw Hill Education; Fifth edition, 978-1259029455
2. E. Kilner & D.M. Samuel,1969, Applied Organic Chemistry, Macdonald & Evans Ltd, Macdonald & Evans Ltd, 978-0712101097
3. Philip Groggins, 2001, Unit Processes in Organic Synthesis, McGraw Hill Education; 5th edition, 978-0074621431

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC21	Core-13 Industrial Utilities (Self-Study)	01 hrs/wk	04 Credits

Objectives:

1. To provide cutting edge knowledge in the field of industrial utilities.
2. To provide skilled manpower for industry requirements.

Unit-I: Air & Inert gas (09 hrs)

- Specifications of air and its industrial use,
- Processing of air,
- Air-Air compressors,
- Properties of Nitrogen and Argon.

Unit-II: Water (09 hrs)

- Sources of water, Impurities in water,
- Hardness of water and its cause,
- types of hardness (1) Temporary Hardness (2) Permanent Hardness,
- Units of Hardness and their interrelation.
- Estimation of hardness by EDTA methods,
- Conditions for boilers feed, water boiler problems.
- Scale and sludge, Priming, Foaming, Carryover, Boiler Corrosion, Caustic Embrittlement,
- Water Softening, Internal Treatment, External Treatment,
- Colloidal Conditioning, Carbonate Conditioning, Phosphate Conditioning, Calgon Conditioning, External Treatment, Zeolite Process, Lime Soda Process, Ion Exchange Process, Mixed Bed Deionizer Process,
- Concept of soft, hard, de-ionized water and distilled water Resins used.

- Regeneration (Ion Exchange and Mixed Bed Deionizer).

Unit-III: Insulation (10hrs)

- Characteristics,
- properties,
- classification:
    - Cold insulation,
    - Low temperature insulation (high vacuum, multiple layer powder, rigid foam).

Unit-IV: Compressed Air

(10 hrs)

- Introduction
- Plant air system
- Instrument air system
- Operation and management
- Safety
- The future

Unit-V:Steam, Steam Generation and Steam Distribution (10 hrs)

- Brief introduction of steam,
- Formation of steam at a constant pressure from water.
- Temperature vs total heat graph during steam formation,
- Important terms for steam (wet steam, dry saturated steam, superheated steam, dryness fraction or quality of wet steam, sensible heat of water, latent heat of vaporization, enthalpy or total heat of steam, specific volume of steam.
- Steam tables and simple numerical problems on them.
- Boilers: Different types of boilers viz. Babcock Wilcox, Nestler, Cochran boilers,
- Boilers accessories like Economizer, ID fan, FD fans, heaters, subeheaters, oil burness, soot blowers.

Text Books:

1. D.B. Dhone, Plant Utilities, Nirali Prakshan Publication

Reference Books:

1. ShashiChawla, DhanpatRai, Industrial Chemistry, Sons Publication.
2. Dr.Mujawar, Plant Utilities, Nirali Prakashan Publication.
3. Max S. Peters, Klaus D. Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill Publication, Fourth Edition, 0-07-0496137.
4. O.P. Gupta, (2002), Fuel Furances and Refractories, Khanna Publishers.
5. Vasandhani, V. P and Kumar, D. S, (2009), Treatise on Heat Engineering, Metropolitan Book Co. Pvt. Ltd.ISBN-9788120003507.
6. Jack Broughton, Process Utility Systems, Institution of Chemical Engineers, ISBN-0852954832

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC01	DSE Core Elective-1 Petroleum & Petrochemicals	04 hrs/wk	04 Credits

Objectives:

1. To understand multi-component fractional distillation of crude petroleum.
2. To classify petroleum products.
3. To carry out analysis of petroleum and its products.
4. To understand flow diagram for manufacturing of petrochemicals.

Unit-I: Introduction of Petroleum and Petrochemicals (9 hrs)

- Introduction to petroleum, Origin and formation of Petroleum, Reserves and deposits of world, Indian Petroleum Industry, Composition of Petroleum
- Classification of Petroleum
- Introduction to Petrochemicals, Petrochemical industry in India and Nature of Indian Crude
- Important petroleum products including gasoline, kerosene, ATF, diesel, fuel oils, lubricants
- Manufacture of petrochemicals
- Feedstock for petrochemicals

Unit-II: Processing Crude Petroleum and Petroleum Product Analysis. (9 hrs)

- Preparation of petroleum for processing
- Overview of Treatment methods for petroleum emulsion & Desalting of petroleum
- Fractional Distillation of crude petroleum, Cuts and composition of fractional distillation
- Cracking and Reforming
- Comparison of thermal and catalytic cracking

- Chemical treatment for upgrading a liquid fuel
- Petroleum product Analysis

Unit-III: Chemicals from C1 Compounds and C2 Compounds (10 hrs)

- Manufacture of the following compounds: Methane, Ethylene, Acetylene
- Manufacture of the following compounds from Methane:
  - Methanol, Hydrogen Cyanide, Carbon disulphide.

- Manufacture of the following compounds from Ethylene:
  - Ethyl chloride, Ethanol, Ethylene oxide, Ethylene glycol, Acetic acid, Styrene, Vinyl Acetate

Unit-IV: Chemicals from C3 Compounds and C4 Compounds (10 hrs)

- Manufacture of the following compounds From Propylene:
  - Isopropanol, Cumene, Glycerin, Acrylonitrile, Propylene oxide, Acrylic Acid and Bis-Phenol.
- Manufacture of the following compounds From C4 hydrocarbons:
  - Butadiene, Isobutane, Butanol, Methaacrylic acid and Maleic anhydride.

Unit-V: Aromatic compounds, Syngas and SNG Production (10 hrs)

- Manufacture of the following compounds: Benzene, Toluene, Xylene, Naphthalene, Linear alkyl benzenes and their sulphonates, Caprolactum and Adipic acid.
- Manufacture of the following compounds:
  - Steam reforming: from natural gas and from naphtha.
  - Scheme for CO & H_2 production
  - SNG production: from naphtha and from via partial oxidation.

Text Books:

1. B.K. Bhaskar Rao, (2002), Petrochemicals, Khanna Publishers, 5th Edition, 8174090444
2. Nelson, (1982), Petroleum Refinery Engineering, McGraw Hill, 4th Edition

Reference Books:

1. A.L. Waddams, (1978), Chemicals from Petroleum, John Murray, 4th revised Edition, 0719535352
2. Rao & M Gopala,1997, Dryden's Outlines Of Chemical Technology, East-West Press, 8185938792

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC02	DSE Core Elective-1 Industrial Safety	04 hrs/wk	04 Credits

Objectives:

1. To Understand of Intrinsic & Extrinsic Safety rules including hazards-Toxicity,Flammability, Fire, Explosions, Sources of Ignition, Pressure, Hazard and Risk assessment methods and MSDS.
2. To understand and identifying safety devices including Pressure Relief Valve, Rupture disks, Blow down Systems, Flare Systems, Flame arresters, Deflagration arresters and explosion suppression, personal safety devices.
3. Comparison, Risk analysis and Estimation, Safety check list and Computer basedquantitative risk analysis.
4. To achieve knowledge of principles of GMP and GLP and its application inpharmaceutical industries including Guidelines, classification, Various Schedule (X, O,M), Violation of GMP and GLP

Unit-I: General Industrial Hazards& Process Safety (09 hrs)

- Types of safety including Intrinsic & Extrinsic Safety.
- Types of hazard including Flammability, Fire, Explosions, Toxicity, Leakage, Fumes, Sources of Ignition, Pressure.
- Hazard and Risk assessment methods and MSDS.
- Checklists for industrial safety.

Unit-II: Process Safety Analysis Safety Devices & (09 hrs)

- Process Safety Analysis: HAZAN and HAZOP comparison, Risk analysis and Estimation, Safety check list, Computer based quantitative risk analysis
- Pressure Relief Valve, Rupture Disks, Blow down Systems, Flare Systems, Flame arresters, Deflagration arresters and Explosion suppression, Personal Safety Devices.

Unit-III: GLP & GMP & Safety standards (10 hrs)

- GMP: Introduction, Various Schedule (X, O, M), Guidelines, Violation of GMP.
- GLP: Introduction, Principles, Resources, Guideline, Violation.
- Safety standards: The Factories Act, 1948 (National),
- ISO 45001 - Occupational health and safety (International)

Unit-IV: Maintenance system for industrial safety (10 hrs)

- Shutdown Management: Introduction, Types of Shutdown, Resource Planning, activity detail, Material procurement, Preparation Pert/Bar chart, Pre-shutdown work,
- Evacuation of Plant and Handing over, Start of work & Review, Pressure testing and handing over, commissioning, Post-shutdown review.

Unit-V: Disaster Management (10 hrs)

- Disaster Management: Introduction, Classification, Disaster preparation, Prevention,
- Management, Natural disaster mitigation.
- Mock drills & training for probable disasters.

Text Books:

1. S.Rao, 2009, *Energy Technology-Conventional &Non-Conventional Systems*, India: Khanna publishers.
2. P. Carson, C. Mumford, 1988, *Safe Handling of Chemicals in Industry*, NY: Longman scientific technical

Reference Books:

1. F.P. Less, 1980, *Loss Prevention in chemical process industries,* Butterworth: Heiremann
2. D.W. Perry, R.H. Perry, 2007, *Chemical Engineers Handbook,* NY: McGraw Hill
3. S. Willing, J. Stocker, 1997, Good Manufacturing Practices, USA: Marcel Dekker
4. J.J. Keller, 1999, *Safety Managers Handbook,* American Management Association International
5. R.E. Johnstone, 1957, *Pilot Plant Models and Scale up Methods in Chemical Engineering,* US: McGraw-Hill

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC03	DSE Core Elective-1 Cement & Ceramic Industries	04 hrs/wk	04 Credit

Objectives:

1. Create skilled manpower for industry requirements at various levels.
2. Provide for Recognition of Prior Learning (RPL) framework for job roles

Unit-I: Cement: (10 hrs)

- Composition of cement,
- Functions of ingredient of ordinary cement,
- Dry process & advantages and disadvantages,
- Wet process & advantages and disadvantages.
- Special types of cements.

Unit-II: Ceramics: (10 hrs)

- Introduction,
- Raw materials of ceramic,
- Types of ceramic, White wares, Manufacturing of white wares,
- Classification and type of White wares,
- Elementary idea of manufacturing process technology including body preparation,
- Basic properties and application areas
- Manufacturing of white wares,
- Glazing & Method of glazing (Salt glazing, Liquid glazing)

Unit-III: Refractory materials: (10 hrs)

- Introduction
- Raw materials for refractory,
- Uses of refractory materials,

- Manufacturing of refractory,
- Properties of refractory,
- Classification of refractory,
- Various uses of refractory materials.
- Selection of refractory,
- Some important refractory's (fire clay, silica, high alumina, bauxite, carbon/graphite).

Unit-IV: Unit Operations in Cement & Ceramic Industries: (10 hrs)

- Introduction,
- Free moisture, Bound moisture,
- Drying curve,
- Equipment (Tray dryer, rotary dryer, Flash dryer, Fluid bed dryer, Drum dryer, Spray dryer).
- Fundamental of Mixing
- Importance of Mixing Technology
- Types of Mixing Equipment
- Tumbler Blenders
- Convective Blender
- Fluidization Blenders / Mixers
- Process safety in operation
- Handling and Storage and transportation.

Unit-V: Bricks: (08 hrs)

- Introduction,
- Types of bricks including, Extruded, Wire-cut, Moulded, Dry-pressed,
- Category of bricks by use including Common or building, Face, Hollow, Perforated, Keyed, Paving, Thin – brick
- Specialized use bricks: Chemically resistant, acid brick, Engineering, Accrington, Fire or refractory, Clinker , Ceramic glazed
- Manufacturing process, Mud brick, Fired brick, Extruded bricks, Melded bricks, Dry-pressed bricks, Rail kilns.

- Properties and uses of bricks (Fire clay bricks, Silica bricks)

Text Books:

1. R. Gopalan, D. Venkappayya, S. Nagarajan, (2013),Engineering chemistry,Vikas Publishing House; Fourth edition (2013), Vol-4, ISBN-13-978-9325969018
2. Regregel,Industrial Chemistry, Reinhold Publication.

Reference Books:

1. Jain & Jain, (2006), Engineering chemistry, Vol-1.
2. M. K. fulekar, (2006), Industrial hygiene and chemical safety, Vol-3.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC22	Core Practical-9 Principles of Chemical Engineering Practical	04 hrs/wk	02 Credits

Objectives:

1. To verify law of crushing and grinding.
2. To understand psychometric analysis of ambient air.
3. To study various unit operations.

Practical:

1) To determine size of the product and reduction ratio of Jaw Crusher.
2) To determine size of the product and reduction ratio of Roll Crusher.
3) To determine size of the product and reduction ratio of Ball Mill.
4) To study differential analysis and cumulative analysis using a sieve shaker.
5) To determine efficiency of a cyclone separator.
6) To study psychometric analysis of ambient air.
7) To draw and study liquid-liquid extraction bimodal curve for $CHCl_3$-CH_3COOH-H_2O system.
8) To draw and study liquid-liquid extraction bimodal curve for CCl_4-CH_3COOH-H_2O system.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC23	Core Practical-10 Heavy Chemicals Practical	04 hrs/wk	02 Credit

Objectives:

1. Apply practical knowledge of heavy chemicals by analyzing heavy chemicals used in chemical Industries.
2. Analyze the practical skill by producing metal based catalyst used in chemical reaction to alter rate of reaction.
3. Obtain valuable heavy products used in various plastic and other Industries as raw materials.

Practical

1. To determine the content of residual silica in give heavy chemical sample by photometric method.
2. To analyze major silica content in given heavy chemical sample by gravimetric method.
3. To determine CO_2 content in given heavy chemical sample.
4. To determine free water in given heavy chemical sample.
5. To determine % loss of drying in given heavy chemical sample.
6. To determine Chlorine content in given heavy chemical sample.
7. To determine combined water in given heavy chemical sample.
8. To manufacture various heavy chemicals.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC04	DSE Core Elective Practical-1 Petroleum Analysis Practical	04 hrs/wk	02 Credits

Course Objectives:

1. To understand multi-component fractional distillation of crude petroleum.
2. To classify petroleum products.
3. To carry out analysis of petroleum and its products.
4. To understand flow diagram for manufacturing of petrochemicals.

List of Experiments:

1. To determine the penetration number of given Bituminous sample.
2. To determine the softening point of Bituminous material (Grease or Wax)
3. To determine the smoke point of light petroleum products.
4. To determine the kinematic viscosity of an oil sample using Redwood viscometer.
5. To determine the kinematic viscosity of an oil sample using Saybolt viscometer.
6. To determine flash and fire point of the given sample by using cleaveland open cup apparatus.
7. To determine the % moisture present in a given sample of liquid petroleum by Dean and Stark's method.
8. Determination of Cloud and Pour point of heavy petroleum product.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC05	DSE Core Elective Practical-1 Industrial Safety Practical	04 hrs/wk	02 Credits

Objectives:

1. To assess risk at various stages of production in chemical industry.
2. To achieve knowledge of principles of GMP and GLP and its application in pharmaceutical industries including Guidelines, classification, Various Schedule (X, O,M), Violation of GMP and GLP.

Industrial Safety & Management:

Risk assessment techniques

- For concentrated acids
- For Toxic material

Case studies on followings:

- Process Safety
- Safety devices & Process safety Analysis
- Shutdown & Disaster Management
- GLP & GMP in Pharmaceutical Industries

Text Books:

1. S.Rao, 2009, *Energy Technology-Conventional &Non-Conventional Systems*, India: Khanna publishers.
2. P. Carson, C. Mumford, 1988, *Safe Handling of Chemicals in Industry*, NY: Longman scientific technical

Reference Books:

1. F.P. Less, 1980, *Loss Prevention in chemical process industries,* Butterworth: Heiremann

2. D.W. Perry, R.H. Perry, 2007, *Chemical Engineers Handbook,* NY: McGraw Hill
3. S. Willing, J. Stocker, 1997, Good Manufacturing Practices, USA: Marcel Dekker
4. J.J. Keller, 1999, *Safety Managers Handbook,* American Management Association International
5. R.E. Johnstone, 1957, *Pilot Plant Models and Scale up Methods in Chemical Engineering,* US: McGraw-Hill

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICDC06	DSE Core Elective Practical-1 Cement & Ceramic Industries Practical	04 hrs/wk	02 Credits

Objectives:

1. Provide broad and fundamental knowledge of Cement industry.
2. Apply basic techniques to prepare Ceramic Item.
3. Understand the basic concept of Cement and Ceramic industries.

Practical:

1. Determination of percentage Moisture content of clay.
2. Measurement of Dry Strength of clays.
3. Determination of heat of hydration.
4. Determination of Bulk density.
5. Determination of false set.
6. Staining test for masonry cement.
7. Determination on free lime in Portland cement.
8. Pozzolanicity test for Portland pozzolana cement.
9. Determination Loss on Ignition.
10. Determination on free lime in Portland cement.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-V

16UICCC24	Core-14 Computer Based Test	-- hrs/wk	01 Credit

Objectives:

1. To revive the fundamentals and principles of core theory courses of industrial chemistry UG program.

- MCQ's based on fundamentals & principles of Core subjects from semester I to semester V.

Course Code	COURSE
16UICCC01	Industrial Instrumentations
16UICCC02	Renewable & Non-Renewable Sources
16UICCC05	Surface Chemistry
16UICCC06	Polymer Chemistry & Technology
16UICCC09	Unit Operations
16UICCC10	Dyes & Dyeing, Pigments & Paints
16UICCC11	Material Science
16UICCC14	Unit Processes
16UICCC15	Analytical Chemical Technique
16UICCC16	Mass & Energy Balance
16UICCC19	Principles of Chemical Engineering-I
16UICCC20	Heavy Chemicals
16UICCC21	Industrial Utilities (Self-Study)

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICCC25	Core-15 Principles of Chemical Engineering-II	03 hrs/wk	03 Credits

Objectives:

1. To study feedback control system.
2. To understand principles of compressor technology.
3. To study refrigeration principles and application.
4. To study evaporation unit operation.

Unit-I: Evaporation **(09 hrs)**

- Introduction and objective,
- Performance of tubular evaporators,
- Construction, Working, Merits and Demerits of following equipments:
  - Short tube (standard) evaporator,
  - Forced circulation Evaporators,
  - Falling film evaporators,
  - Climbing film evaporators,
  - Wiped film evaporator,
  - Multiple effect evaporators.

Unit-II: Industrial Engineering **(06 hrs)**

- Development of the project,
- Evaluation of process, choice of process, plant design factors,
- Selection of equipment for chemical plant,
- Selection of material of construction and equipments,
- Various engineering properties of materials,
- Various types of reactor and reaction vessels.

Unit-III: Process Controls **(09 hrs)**

- Control system and its components,
- Feedback control system, Comparison between positive feedback and negative feedback, block diagram,
- Terminologies,
- Transfer function,
- Transportation lag,
- Closed and open loop control system.
- Control valves.
- Modes of control:
  - On-Off control,
  - Proportional Control,
  - Proportional Integral Control,
  - Proportional Integral Derivative Control.

Unit-IV: Compressors **(06 hrs)**

- Definition, classifications and applications of compressors,
- Various important terminologies,
- Working of a reciprocating compressor.
- Derivation of work requirement in adiabatic and isothermal compression,
- Effect of clearance,
- Volumetric efficiency,
- Multi compression.

Unit-V: Refrigeration **(06 hrs)**

- Definition and importance of refrigeration,
- COP,
- Difference between heat engine, refrigerator and heat pump.
- Air conditioning,
- Characteristics of good refrigerants,
- Classification of refrigerants,
- Properties of refrigerants,
- Industrially important refrigerants:
  - Ammonia, CO_2, SO_2, Freon-12, Brine,
- Coding of various types of refrigerants,

Text Books:

1. CP Arora, (2000), Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Limited, ISBN: 0-07-463010-5
2. K.A. Gavhane, (2009), Unit Operations-I, Nirali Publications, ISBN: 978-81-96396-11-4

Reference Books:

1. OP Khanna, (1985), Industrial Engineering and Managment, Dhanpat Rai & Sons,
2. SM Yahya, (2011), Turbines Compressors and Fans, Tata McGraw Hill Publishing Company Limited, ISBN: 1-25-900072-9

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICCC26	Core-16 Fine Chemicals	03 hrs/wk	03 Credits

Objectives:

1. Develop the skill for manufacture of fine chemicals used in chemical Industries.
2. Apply practical knowledge by synthesizing speciality chemicals used in food Industries.
3. Emphasize the skilled based approach by producing fine & speciality chemicals used as emulsifier and surfactant.

Unit-I: Introduction to Fine Chemicals: (09 hrs)

- Manufacture of following fine chemicals with reference to raw material production process, quality control and specifications of common industrial compound involving two step reactions,
- Sodium borohydrate, Llithium aluminium hydride, sodium amide, sodium ethoxide, sodium methoxide, Carbon tetra chloride, chloroform.

Unit-II: Reagents & Common Solutions (09 hrs)

- Reagents :Laboratory chemicals from heavy chemical industry in required purity : Acids, alkalis, carbonates, drying agents.
- Analytical Reagents : Sodium carbonate, Sodium bicarbonate, Potassium dichromate, Oxalic acid, Perchloric acid.
- Common solutions : Fehling solution, Karl-Fisher reagent.

Unit-III: Speciality industrial solvents & Food Additives (09 hrs)

- Speciality industrial solvents -DMF, DMSO, Sulpholane, Alkyl Pyrrolidone, Furan, THF, Diethyl ether, Dimethoxy ethane, Dioxane, N-alkylated ethanol amine.

- Food additives: classification, food additive compounds like Monosodium glutamate, Tartaric acid, Citric acid with manufacturing processes.

Unit-IV: Essential oils & Organic flavouring agents (10 hrs)

- Essential oils: Sources of essential oils, Extraction of essential oils. Composition and production of some essential oils.
- General organic flavour camphor, citrol, citronellol, methanol, vanillin, cinnamal, Coumarin, Phenyl ethyl alcohols, Musk embrittle / ketones

Unit-V: HPLC solvents, Surfactants & Emulsifiers: (10 hrs)

- HPLC solvents: Spectroscopy grade chemicals, methanol, ethanol, potassium bromide, Nujol
- Biochemical Reagents :Ninhydrin, Tetrazolium blue.
- Surfactants : Classification, Industrial application
- Emulsifers : Types, HLV concept, Tweens, Spans.

Text Books:

1. William Lawrence Faith, 1975, Industrial Chemicals, John Wiley & Sons Inc; 4th Revised edition, 978-0471549642
2. Rao & M Gopala,1997, Dryden's Outlines Of Chemical Technology, East-West Press, 8185938792

Reference Books:

1. A.Cybulski M.M. Sharma R.A. Sheldon & J.A. Moulijn, 2001,Fine Chemicals Manufacture, 9780080542294
2. Peter Pollak, 2011, Fine Chemicals: The Industry and the Business, 9780470627679

B.SC. INDUSTRIAL CHEMISTRY
SEMESTER-VI

16UICCC27	**Core-17** Bulk Drugs, intermediates & API	03hrs/wk	03 Credit

Unit-I: Pharmacopoeia & Dosage Forms (07hrs)

- Historical background and development of pharmaceutical industry in India in brief.
- Pharmacopoeias: Development of Indian pharmacopoeia.
- Introduction to various types of formulations and routes of administration & Need for dosage form.
- Introduction to pharmaceutical packaging, packaging materials & quality control of packing materials.

Unit-II: Pharmaceutical Excipients & Surgical Dressings (08hrs)

- Study of various pharmaceutical excipients like:
  - Glidents, Lubricants, Diluents, Preservatives, Antioxidants, Emulsifying agents, Coating agents, Binders, Coloring agents, Flavoring agents, Gelatine, etc.
- Study of various pharmaceutical surgical dressings like:
  - Gauges, Bandages, Sutures and Ligatures with respect to the process, manufacture, methods of sterilization and uses.Pharmaceutical quality control techniques like: sterilization and pyrogen testing, aseptic condition, etc.

Unit-III: Bulk Drug (07hrs)

- Introduction and study of various bulk drugs like:
  - Anaesthetic: Benzocaine
  - Analgesics, Antipyretic and Anti-inflammatory: Paracetamol, Phenacetin, Mefenic acid, etc.
  - Barbiturates: Phenobarbitol, Pentobarbitol, Talbutal, Butalbital, etc.
  - Anti-hypertensive & Cardiovascular Agents: Methyldopa, β-blockers: Propanolol, Atenolol, etc.
  - Antimicrobials: Chloramphenicol, Isoniazid, PAS, etc.

Unit-IV: Industrial Microbiology (07hrs)

- Introduction to micro-organisms.
- Classification and structure of Bacteria, Enzyme system in bacteria, Factors affecting bacterial growth &Conditions affecting enzyme substrate activity.
- Production of various fermentation products like Lactic acid, Vinegar production, Baker's yeast, Penicillin-V, Penicillin-G

Unit-V:Phytochemicals & Quality control (07hrs)

- Introduction to plant classification and evaluation of crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants.
- Chemical constituents of plants including carbohydrates, amino acids, proteins, Terpenoid.

Text Books:

1. Ashok K Gupta, (2007), Introduction to Pharmaceutics, Paperback, Vol. 1,
2. Ravi shaker S, Textbook of Pharmaceutical analysis
3. Wilson &Gisvold (2010)– Text book of Organic Medicinal and Pharmaceutical Chemistry.9788184733969
4. Connors, Kenneth A., (1968), Textbook of Pharmaceutical Analysis, J. Chem. Educ.
5. KarAshutosh, (2012), Pharmaceutical Drug Analysis, Paperback, Vol. 3, ISBN: 978-81-224-3273-2.
6. Mullertz, Annette, Perrie, Rades, Thomas, Analytical techniques in the pharmaceutical sciences, (2016), ISBN: 978-1-4939-4029-5

Reference Books:

1. Indian Pharmacopoeia 2014, 7th edition / IP 2014 (7.0) (4 Volumes with addendum 2015 and addendum 2016), ISBN-10: 93-81238-07-3 / 9381238073
2. Practical pharmacognosy T.N. Vasudevan.
3. P.P. Singh and D.W. Rangnekar, An introduction to Synthetic drugs; Himalaya Publication, Bombay.
4. G. R. Chatwal, Synthetic Drugs, , Himalaya Publication.
5. Mebrotra, Hand book of Drugs and Cosmetic Acts..
6. W.O. Foye, Principles of medicinal chemistry, Lea and Febigen Publication, Philadelphia.
7. T.B. Willis, Practical pharmacognosy.
8. Ramstand, Modern pharmacognosy: McGraw Hill.
9. Daniel Lednice and L.A. Mitscher, Organic chemistry of Drugs Synthesis; Wiley Interscience.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC07	DSE Core Elective-2 Industrial Management	04 hrs/wk	04 Credits

Objectives:

1. Interpret given organization structure, culture.
2. Explain material requirement planning and store keeping procedure.
3. Plot and analyze inventory control models and techniques
4. Production management and process management.
5. To maintain quality in production.

Unit-I: Introduction of Industrial Management. (09 hrs)

- Fayol's 14 Principles of Management
- System- concept, definition, types, parameters, variables and behavior.
- Management – definition and functions.
- Organization structure: i. Definition. ii. Goals. iii. Factors considered in formulating structure. iv. Types. v. Advantages and disadvantages. vi. Applications.
- Concept, meaning and importance of division of labor, scalar & functional processes, span of control, delegation of authority, centralization and decentralization in industrial management.
- Organizational culture and climate – meaning, differences and factors affecting them.
- Job satisfaction- factors influencing job satisfaction.

Unit-II: Production Planning & Control. (09 hrs)

- Types and examples of production.
- PPC: i. Need and importance. ii. Functions. iii. Forms used and their importance. iv. General approach for each type of production.
- Scheduling- meaning and need for productivity and utilisation.
- Gantt chart- Format and method to prepare.

- Critical ratio scheduling-method and numeric examples.

Unit-III: Materials Management. (10 hrs)

- Material management-definition, functions, importance,
- Purchase - objectives, purchasing systems, purchase procedure, terms and forms used in purchase department.
- Storekeeping- functions, classification of stores as centralized and decentralized with their advantages, disadvantages and application in actual practice.
- Functions of store, types of records maintained by store, various types and applications of storage equipment, need and general methods for codification of stores.
- Inventory control: i. Definition. ii. Objectives. iii. Derivation for expression for Economic Order Quantity (EOQ) and numeric examples. iv. ABC analysis and other modern methods of analysis.
- Material Requirement Planning (MRP)- concept, applications and brief details about software packages available in market.

Unit-IV: Total quality management for production. (10 hrs)

- Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework
- Quality circles Recognition and Reward, Performance appraisal.
- ISO 9000 family of quality management systems for production.

Unit-V: Case studies on industrial management (10 hrs)

- Successful projects(at least two)
- Failed projects (at least two)
- Sustained Organizations (at least one)

Text Books:

1. Singhal R, (2012), Industrial Management.

Reference Books:

2. Ravi Shankar, (2003), Industrial Engineering and Management 2nd Edition, Galgotia Publications.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC08	DSE Core Elective-2 Chemistry of Natural Products	04 hrs/wk	04 Credits

Objectives:

1. Identify and characterize various classes of natural products by their structures
2. Escalate the biogenesis of many natural products of importance;
3. Have some knowledge of some of the plants around them and their pharmaceutical importance.
4. Have acquired the skills to isolate and purify simple products that are derived from plants and some animals;
5. Have acquired the skills to perform routine instrumental analysis on these products for the purpose of identification;

Unit-I: Fundamentals of Natural Product Chemistry (09 hrs)

- Introduction,
- Historical developments,
- Primary & secondary metabolites,
- Classification, role & importance, characteristics.

Unit-II: Steroids (09 hrs)

- Introduction,
- Classification,
- Extraction and
- Isolation, basic skeleton, representative examples:
    - Cholesterol,
    - Bile acids,
    - Sex hormones.

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

- Introduction,
- Classification,
- Nomenclature,
- Isolation, isoprene rule, representative examples:
    - Monoterpenoids – citral,
    - Monocyclic monoterpenoids – menthol,
    - Bicyclic monoterpenoids – camphor, sesquiterpenoids – zingiberene.

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

- Introduction,
- Classification,
- Nomenclature,
- Pro-vitamin,
- Functions,
- Sources.

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

- Introduction,
- Occurrence,
- Classification,
- Isolation,
- Importance,
- Characteristics,
- Representative examples:
    - Nicotine,
    - Atropine,
    - Morphine.

Text Books:

1. F. Louis, F. Mary, (1959), Steroids, New York Reinhold, ISBN: 1258535424
2. P.S. Kalsi, (2012), Organic, Medicinal and Natural products chemistry, Alpha Science Intl Ltd; 1 edition, ISBN: 1842655981
3. P. Manitto, (1981), Biosynthesis of Natural Products, John Wiley & Sons, ISBN: 0853120625

Reference Books:

1. P.S. Kalsi, (2012), Organic, Medicinal and Natural products chemistry, Alpha Science Intl Ltd; 1 edition, ISBN: 1842655981

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC09	DSE Core Elective-2 Surface Coating Techniques	04 hrs/wk	04 Credits

Objectives:

1. Create skilled manpower for industry requirements at various levels.
2. Provide for Recognition of Prior Learning (RPL) framework for job roles

Unit-I: Surface coating: (09 hrs)

- Introduction,
- Raw materials & treatment of raw materials
- Preliminary treatment of surfaces,
- Objective of Coating (on metal & non-metals),
- Classification of surface coatings (inorganic& organic)
- Importance of surface coating

Unit-II: Inorganic surface coating: (10 hrs)

- Anodic coating, cathode coatings
- Hot dipping(Galvanizing, tinning),
- Metal spraying,
- Cementation,
- Metal cladding,
- Vacuum metalizing,
- Electrophoretic coating,
- Surface conversions,
- Vitreous coating.
- Anodizing.
- Cathode sputtering.

Unit-III: Electroplating: (09 hrs)

- Theory of electroplating
- Evolution & recent trends in electroplating Technology
- Types of electroplating
- Precautionary measures for proper electroplating
- Electroplating of certain metals including
    - Nickel
    - Chrome
    - Silver
- Non metallic coating (plastic coating)

Unit-IV: Characteristics of electro – deposit and factors affecting: (10 hrs)

- Thickness,
- Adherence,
- Hardness,
- Brightness,
- Protective value,
- Decorative value,
- Throwing power,
- Temperature,
- pH of the bath liquid.

Unit-V: Organic surface coating: (10 hrs)

- Oil paints,
- Water paints (emulsion paints),
- Varnishes,
- Lacquers and wax polishes
- Special paints.

Text Books:

1. W.Ryan, Properties of ceramic raw materials, Engineering chemistry ,Vikas Publishing House, 2nd Edition, eBook ISBN- 9781483146591
2. J.C. Kuriacose & J. Rajaram (1984), Chemistry in engineering and technology, volume -1 & 2, Tata McGraw Hill Education, ISBN0074517368, 9780074517369

Reference Books:

1. S. Kumar: Hand book of ceramics, Vol – I & II. ISSN: 0371-750X
2. Ullmann's,(December 5, 1995),Ullmann's Encyclopedia of Industrial Chemistry,VolumeB8,Edition,ISBN-10: 3527201386.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICCC28	Core Practical-11 Fine Chemicals Practical	04 hrs/wk	02 Credit

Objectives:

1. Apply experimental knowledge of fine chemicals by analyzing fine chemicals used in chemical Industries.
2. Analyze the practical skill by producing metal based catalyst used in chemical reaction to alter rate of reaction.
3. Obtain valuable fine products used in various plastic Industries as a raw materials.

Practical

1. To analyze the total alkalinity of given fine chemical sample.
2. To determine the content of common salt in give fine chemical sample.
3. To determine Iron content in given fine chemical sample.
4. To analyze gravimetric determination of sodium sulphate in given fine chemical sample.
5. To determine % moisture content in given fine chemical sample.
6. To determine % loss of drying in given fine chemical sample.
7. To determine Chlorine content in given fine chemical sample.
8. To determine Specific gravity of given fine chemical sample.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICCC29	Core Practical-12 Bulk Drugs, Intermediates & API Practical	04 hrs/wk	02 Credits

Objectives:

1. Develop a practical skill for pharmaceutical industries
2. Apply the knowledge of pharmaceuticals to industry

Pharmaceutical Preparation:

1. To prepare cold cream
2. To prepare aspirin from salicylic acid
3. To prepare methyl salicylate from salicylic acid
4. To prepare Glucosazone from Glucose

Pharmaceutical Estimation:

1. Estimation of Aspirin by analytical technique.
2. Estimation of Lactic acid from the given sample.
3. Estimation of Vitamin C from the given sample.
4. Estimation of Isoniazid from the given sample.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC10	DSE Core Elective Practical-2 Industrial Management Practical	04 hrs/wk	02 Credits

Objectives:

1. To understand industrial projects.
2. To understand industrial planning.
3. To create checklists for production management.
4. To create Gantt charts of production.
5. To interpret and discuss case studies.

- Prepare Gantt chart for any five chemical production processes.
- Create check lists for successful quality management.
- Case studies on different production management examples.

Text Books:

1. Singhal R, (2012), Industrial Management.

Reference Books:

1. Ravi Shankar, (Year), Industrial Engineering and Management 2nd Edition, Golgotha Publications.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC11	DSE Core Elective Practical-2 Chemistry of Natural Products Practical	04 hrs/wk	02 Credits

Objectives:

1. Identify and characterize various classes of natural products by their structures
2. Appreciate the biogenesis of many natural products of importance;
3. Have some knowledge of some of the plants around them and their pharmaceutical importance.
4. Have acquired the skills to isolate and purify simple products that are derived from plants and some animals;
5. Have acquired the skills to perform routine instrumental analysis on these products for the purpose of identification;

Practicals:

1. Extraction and identification of natural product component present in turmeric powder.
2. Isolation and identification of alkaloid piperine from black pepper seed.
3. To isolate and extract caffeine from tea leaves.
4. Extraction of alkaloid nicotine from tobacco leaves.
5. To extract carotenoid pigment from tomato.
6. To extract carotenoid pigment from carrot.
7. To extract and isolate essential oil of clove by simple distillation method.
8. To extract and isolation of essential oil from cinnamon.

B.SC. INDUSTRIAL CHEMISTRY

SEMESTER-VI

16UICDC12	DSE Core Elective Practical-2 Surface Coating Techniques Practical	04 hrs/wk	02 Credits

Objectives:

1. Provide broad and fundamental knowledge of Surface coating industry.
2. Apply basic techniques to prepare Coating Item.
3. Understand the basic concept of Coating industries.

Practical:

1. To electroplate silver on given object.
2. To determine the amount of silver in silver plating bath.
3. To determine the amount of silver metal as silver sulphide by gravimetrically.
4. To determine the amount of nickel in bath.
5. Determine the amount of Ni as Nickel dimethyl glyoxime (Ni $(C_4H_7O_2)_2$) gravimetrically from the acidic solution of $NiSO_4.7H_2O$
6. To electroplate copper on given object
7. To determine the amount of copper sulphate in copper plating bath.
8. To determine the amount of copper in copper plating bath by gravimetric analysis
9. To electroplate chrome on given object.
10. To determine the amount of chrome in chrome plating bath.