**Enclosure IV**

**SHRI MANIBHAI VIRANI & SMT. NAVALBEN VIRANI SCIENCE COLLEGE (AUTONOMOUS), RAJKOT**

**B.SC. INDUSTRIAL CHEMISTRY**

**SEMESTER-I**

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| 19UICCC101 | **Core-1**<br>Industrial Instrumentations | 04 hrs/wk | 04 Credit |

## Objectives:

1. Compare direct and indirect methods of measurement of industrial parameters
2. Explain role of Industrial instrumentation including Temperature, Pressure, Viscosity, Liquid level and Density
3. Calibration of the instruments applied for Temperature, Pressure, Viscosity, Liquid level and Density measurement
4. Knowledge of techniques used for the measurement of industrial parameters.
5. Discuss conversion of units for measurement of industrial parameters.

### Unit-I: Basics of industrial Instrumentation (12 Hrs)

- An introduction to Instrumental methods, Major steps in solving an analytical problem, Basics functions of instruments
- Measurement, Signals and Data: Signal-to-Noise ratio, Sensitivity and Detection limit
- Noise, Accuracy and Instrument calibration, the meaning of measurement
- Basics of Industrial Instrumentation:
- Introduction, Types of measurement: Direct measurement, indirect measurement, Functions of measuring instruments, Elements of instrument, Classification of measuring instrument,
    - According to operation
    - According to the source of power
    - According to the arrangement
    - Characteristics of an instrument: Static characteristics and Dynamic characteristics

### Unit-II: Viscosity (12 Hrs)

- Introduction
- Principle, construction and working of following Viscosity measurement devices:
  1. Orifice type viscometer
  2. Falling sphere viscometer
  3. Rotational viscometer
  4. Brookfield viscometer
  5. Saybolt viscometer
  6. Redwood viscometer
  7. Ostwald viscometer

## Unit-III: Temperature (12 Hrs)

- Introduction, various Temperature scales
- Construction of the element of Temperature measuring elements:
- Thermometer bulb and well, Thermometer capillary and armor, Receiving element
- (Pressure spring), Recording (Indicating) element
- Principle, construction and working of following Temperature measuring instruments:
  1. Volume gas thermometer
  2. Glass thermometer
  3. Bimetallic thermometer
  4. Pressure spring thermometer
  5. Vapour actuated thermometer
  6. Pneumatic balance pressure thermometer
  7. Resistance thermometer
  8. Industrial resistance thermometer bulbs (RT bulbs)
- Introduction, Laws of radiation
- Principle, construction and working of following Radiation Temperature measuring instruments:
  1. Radiation pyrometers
  2. Black body devices
  3. Vacuum thermocouple
  4. Balometer
  5. Photoelectric pyrometer
  6. Optical pyrometer

## Unit-IV: Pressure (12 Hrs)

- Introduction,
- Principle, construction and working of following Pressure measurement devices:
- Liquid column manometer:
  -U-tube manometer
  -Inclined manometer
  -Well type manometer
  -Ring type manometer
  1. Barometer
  2. Bourdon gauge
  3. Bellows gauge
  4. Diaphragm gauge
  5. McLeod gauge
  6. Thermal conductivity gauge
  7. Pirani gauge
  8. Thermocouple gauge
  9. Ionization gauge
- **Measuring pressure in corrosive fluids:**
  1. Single coil siphon
  2. Diaphragm seal
  3. Liquid seal
  4. Purge system

## Unit-V: Liquid level and Density (12 Hrs)

- Introduction, Methods of liquid level measurement: Direct method and indirect method
- Principle, construction and working of following Liquid level measurement devices:
- Direct methods :Hook type level indicator, Sight glass, Float type level indicator
- Indirect methods : Pressure gauge method, Bubbler system, Diaphragm box system,-Air-trap system
- Level measurement for dry materials.

**Level measurement in pressure vessels:**

- Radiation level indicator
- Ultrasonic method for level measurement

**Density measurement:**

- Introduction
- Principle, construction and working of following Density measurement devices:
  1. Liquid level method of measuring specific gravity or density,
  2. Displacement meter for measuring specific gravity or density,
  3. Hydrometer

**Text Books:**

1. D.P. Eckman, (2014), Industrial Instrumentation, John-Wiley's and sons.
2. W. Merritt and D. Settle, 7th Edition, Instrumental methods of Analysis, CBS Publishers

**Reference Books:**

1. W.G. Andrews, Applied Instrumentation in process industries, volume 1, 2 and 3, Gulf Publication
2. S. Borer Instrumentation and Control for the process industries Elsevier applied science publisher

| 19UICCC102 | **Core-2**<br>Renewable & Non-Renewable Sources | 04 hrs/wk | 04 Credits |
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**Objectives:**

1. Determine Industrial fuels its specific utilization.
2. Enhance the skill of industrial fuel production and their processes.
3. Study renewable natural resources and their production processes.
4. Determine utilization of natural resources.

## Unit-I: Liquid Fuel –Petroleum (12 Hrs)

- Introduction to petroleum, Definitions, Origin of Petroleum, Petroleum Production, Composition of Petroleum.
- Classification of Petroleum, Nature of Indian Crude.
- Top Ten Refinery of India.
- Flow sheet of petroleum refinery.
- Important petroleum products including gasoline, kerosene, ATF, diesel, fuel oils, lubricants.
- Storage and handling of liquid fuels.
- Liquid fuels from sources other than petroleum including coal tar.
- Storage and handling of liquid fuels including ring main system.

## Unit-II: Processing of liquid fuels (12 Hrs)

- Petroleum processing, physical separation includes three stage distillation process, breakdown processes including fluidized bed catalytic cracking & Dubb's process.
- Rebuilding processes including Polymerization, alkylation, isomerization & hydrogenation.
- Purification processes of petroleum products including Desulfurization, neutralization, solvent extraction, deasphalting, dewaxing & deoiling.

## Unit-III: Solid Fuel -Coal (12 Hrs)

- Definitions, units and measures, origin of coal, rank of coal including peat, lignite, bituminous, anthracite, graphite, Natural coke and (jhama)/SLV.
- Ultimate and proximate analysis of coal, GCV, NCV, Preparation.
- Storage and handling of coal, coal carbonization including beehive oven, vertical and horizontal retorts including continuous and intermittent type; briquetting of coal.
- Coke from petroleum (delayed coker)
- Liquefaction and gasification of solid fuels for manufacturing coal tar, coal gas, producer's gas, purification of coal gas.

## Unit-IV: Gaseous Fuels: Natural & Synthetic (12 Hrs)

- Natural gas, composition of natural gas, handling and storage of natural gas,
- Natural gas production process, units and measures of Natural gas.
- CNG, PNG, LPG their production.
- Types of combustion processes, surface combustion, flameless combustion, submerged combustion, explosion flame, pulsating combustion, slow combustion, combustion of grate, combustion appliances, gas burners, oil burners, solid burner

**Unit-V: Renewable Natural Source (12 Hrs)**

- Cellulose, its preparation and properties, Nitrocellulose, Cellobiose, Celluloid
- Artificial silk, Acetate Silk, Cuprammonium process (Cupra Silk), Viscose silk (Rayon).
- Paper, Caustic soda process and Sulphite process
- Starch, Manufacturing of starch from corn, Properties & uses of Starch, Dextrin, Glycogen, Inulin, Raw starch, Tapioca starch, Iodized starch.
- Alcohols, Methyl alcohol, Ethyl alcohol, Denatured alcohol, Special solvent alcohol, Propyl alcohol, Butyl alcohol, Carboxy Methyl Cellulose(CMC)

**Text Books:**


1. B. K. Sharma, (2014), *Industrial Chemistry*, Krishna Publication ISBN: 978-81-8283-829-1.
2. Samir Sarkar, (2010), *Fuel & Combustion* (3Rd Edition), Orient BlackSwan, 1974. ISBN, 8173716692, 9788173716690. Length, 482 pages.


**Reference Books:**


1. E.J. Hoffman, (2014), *Coal conversions*, Theenergon co. Lavamic, WyomingUSA.
2. Hall A.G. (2012), *Cotton – Cellulose: It's Chemistry & Technology*.

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| 19UICCC103 | **Core Practical-1**<br>Industrial Instrumentations Practical | 06 hrs/wk | 02 Credits |

## Objectives:

1. Compare direct and indirect methods of measurement of industrial parameters
2. Explain role of Industrial instrumentation including Temperature, Pressure, Viscosity, Liquid level and Density
3. Calibration of the instruments applied for Temperature, Pressure, Viscosity, Liquid level and Density measurement
4. Knowledge of techniques used for the measurement of industrial parameters.
5. Discuss conversion of units for measurement of industrial parameters.

## List of Experiments:

1. Determination of pressure using Bourdon's pressure gauge.
2. Determination of blood pressure using Blood pressure measurement unit.
3. To measure pressure of a gas in pipeline using mercury U tube manometer.
4. To determine Viscosity of liquid, flow time and concentration of unknown solution.
5. To determine Viscosity, flow time and concentration of liquid mixture (Glycerol & Water) by Ostwald's viscometer.
6. To determine absolute viscosity of 10%, 5%, 2.5% glycerine solution and concentration of unknown solution by Oswald's viscometer.
7. To determine relative viscosity of pure liquid A, B, C and D by Ostwald's viscometer.
8. Determination of Viscosity of unknown substance using Brookfield digital viscometer.
9. To calibrate the given thermometer with solid substance.
10. To measure relative body temperature using body temperature measurement unit.
11. To measure relative temperature using contact temperature meter.
12. To measure relative Infrared temperature using IR temperature measurement gun.
13. To measure the flow rate and determine co-efficient of discharge flow of water flowing through a pipeline using venturimeter.
14. To measure the flow rate and determine co-efficient of discharge flow of water flowing through a pipeline using orificemeter
15. To measure the flow rate of water in a pipeline using Rotameter.
16. To determine specific gravity of petroleum sample using Pycnometer.
17. To determine specific gravity of sample using Hydrometer.
18. To determine specific gravity of inorganic solvent using Pycnometer.
19. To determine kinematic viscosity of oil using Saybolt viscometer.
20. To determine kinematic viscosity of oil using Redwood viscometer.

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| 19UICCC104 | **Core Practical-2**<br>Renewable & Non-Renewable Sources Practical | 06 hrs/wk | 02 Credits |

## Objectives:

1. Determine Industrial fuels its specific utilization.
2. Enhance the skill of industrial fuel production and their processes.
3. Study renewable natural resources and their production processes.
4. Determine utilization of natural resources.

## List of Experiments:

1. Study the distillation techniques of petroleum mixture (solid and liquid) by simple distillation.
2. Crystallize recovered solid mixture from simple distillation.
3. Recrystallize given impure organic substance & find out percentage purity.
4. Recrystallize given impure inorganic substance & find out percentage purity.
5. Study the distillation techniques of petroleum mixture (liquid and liquid) by fractional distillation.
6. Find purity of liquid distillate by physical method.
7. Perform liquid phase thermal cracking of heavy petroleum oil to produce light hydrocarbon.
8. Perform liquid phase thermal cracking of Tar to produce light hydrocarbon.
9. Desulfurize given raw hydrocarbon by Girbotol process.
10. Desulfurize given raw hydrocarbon by Shell process.
11. Desulfurize given raw hydrocarbon using caustic soda.
12. Find out proof value of given alcohol by ABV method.
13. Find moisture content of coal.
14. Find ash content of coal.
15. Prepare cellulose acetate from raw cellulose.
16. Prepare biodegradable polymer film from starch.
17. Prepare biodegradable polymer film from corn starch & additive materials.
18. Determine pressure drop of ring main system.
19. Find moisture content of petroleum products by Karl Fischer manual method.
20. Prepare paper from pulp by caustic soda process.

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER II**

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| 19UICCC201 | **Core-3**<br>Surface Chemistry | 05 hrs/wk | 05 Credits |

## Objectives:

1. Evaluate and describe colloidal Nano-technological and chemical systems, processes and products
2. Use different theories to calculate surface and interfaces tensions and use this to estimate e.g. wetting and other system characteristics
3. Describe the conditions for stability of colloidal systems and discuss and compare different mechanisms for stabilization
4. Describe mechanisms for stabilization of emulsions and foam, and design emulsions and foam.

## Unit-I: Adsorption (15 Hrs)

- Adsorbate, Adsorbent, Adsorption of gases by solid,
- Physical & Chemical adsorption, Factors affecting adsorption, Adsorption isotherms, Freundlich isotherm, Langmuir Adsorption,
- BET theory including calculations, Adsorption of solute from solution,
- Formation of surface films, Applications of adsorption Application of Ion exchange adsorption.
- Surface active agents and their classification, concept of micelles, critical micelle concentration (CMC).
- Application of surfactants.

## Unit-II: Corrosion-I (15 Hrs)

- Introduction, Rusting, Causes of corrosion,
- Classification of corrosion, Dry corrosion or direct chemical corrosion, Wet corrosion or electrochemical corrosion, Liquid metal corrosion, Oxidation corrosion,
- Pilling-Bedworth rule, Corrosion by other gases, Hydrogen embrittlement, Decarburation,
- Electrochemical series, Galvanic series, Factors influencing corrosion.
- Mechanism of wet corrosion by Evolution of $H_2$ gas, Absorption of $O_2$ gas.
- Various types of corrosion, Galvanic corrosion, Concentration cell corrosion, Differential cell corrosion, Atmospheric corrosion, Stray current corrosion, Underground or soil corrosion, Microbiological corrosion, Uniform corrosion, Pitting corrosion, Stress corrosion, Erosion corrosion, Fretting corrosion.

## Unit-III : Corrosion-II (15 Hrs)

- Cavitation corrosion, Crevice corrosion
- Corrosion control and protection techniques,Proper designing of materials.
- Use of highly pure metals, Use of metal alloys, Use of special heat treatments, Cathodic protection, Super imposition of impressed current, Sacrificial anode, Use of inhibitors, Modifying the environment.
- Use of protective surface coatings. Metallic coatings, Anodic coating, Cathodic coating, Hot dipping, Metal spraying, Electroplating, Galvanizing, Cladding, Vapour plating, Cementation, Inorganic coating, Phosphate coating, Chromate coating, Chemical oxide coating, Vitreous coating, Organic coating, Paints, Varnishes, Lacquers, Shellac, Emulsion paints, Enamels, Organic linings (rubber

and plastics), Distempers, Cement paints, Tin plating, Desiccant method, VCI method.

- Inhibition efficiency and factors influencing inhibition efficiency, measurement of inhibition efficiency.

**Unit-IV: Catalysis (15 Hrs)**

- Introduction of homogeneous & heterogeneous, positive & negative catalysis, Characteristics of catalytic reaction, Promoters, Catalytic poisoning, Autocatalysis, Activation energy & catalysis
- Theories of catalysis with mechanism (intermediate compound formation & adsorption theories), Acid-Base catalysis, Enzyme catalysis, Mechanisms, Characteristics of enzyme catalysis, Some industrial importance of catalytic process.
- Methods of catalyst preparation.

**Unit-V: Colloidal Solution (15 Hrs)**

- Colloidal dispersion introduction & its classification, Lyophilic and Lyophobic colloids, Colloidal solution preparation and purification, Optical properties of sols, Kinetic properties of sols, Sedimentation of suspension, Electrophoresis, Electro-osmosis, Stability of suspension, Precipitation of sols, Macromolecules and their molecular weight determination method.
- Emulsions, Gels, Surfactants, Hydrophile - Lipophile Balance. Determination of CMC by conductivity and surface tension methods; factors affecting CMC

**Text Books:**


1. Puri L.R. and Sharma B.R.,(1998),*Physical Chemistry,*NewDelhi: Chand S. &Co.
2. B.R. and Boyd L.L., 1999. *Organic Chemistry*. New Delhi: ELBS.


**Reference Books:**


1. J.J. Bikerman, 1972. *Surface Chemistry*. New York: Academicpress
2. A.W. Adamson, 1960. *Physical Chemistry of Surfaces.*New York: Inter science publishers Inc.
3. B.K. Sharma, 2001. *Industrial Chemistry.* New Delhi: Chand S. and Co.

| 19UICCC202 | **Core-4**<br>Polymer Chemistry & Technology | 04 hrs/wk | 04 Credits |
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**Objectives:**

1. Determine different polymers their properties and access them according to their industrial applications.
2. Study different polymerization techniques & their mechanisms.
3. Know Industrial polymer processing & their engineering aspects.

## Unit-I: Introduction (12 Hrs)

- Polymer, Oligomer, Macromolecules,
- Classification of polymer, Sources of polymer, Monomers, Functionality concept, Concept of Cross linking.
- Molecular weight and molecular weight distribution number, Weight and viscosity average molecular weight of polymers. Method of determining molecular weight,
- Practical significance of molecular weight distribution.

## Unit-II: Properties of polymer (12 Hrs)

- Physical properties including Density (ρ), Solubility, Flammability, Water absorption – Equilibrium (ASTM), Water absorption – over 24 hours,
- Radiation resistance, Ultraviolet (1-380nm) resistance.
- Mechanical Properties including, Crystalinity, Tensile strength (σt), Elongation (ε) at break, Compressive strength (σc), Abrasive resistance, Coefficient of friction (μ) Thermal Properties including Melting temperature (Tm), Glass transition temperature (Tg) & Factor affecting GTT, Heat deflection temperature, Upper working temperature, Lower working temperature, Thermal conductivity (k),
- Chemical Properties including Acids, Alcohols, Alkalis, Aromatic hydrocarbons, Greases & Oils, Halogenated Hydrocarbons, Halogens, Ketones. Infrared Transmittance Spectrum.

## Unit-III: Polymerization Techniques (12 Hrs)

- Polymerization techniques including three stage addition polymerization,
- Condensation, Ionic and Coordination
- Detail study of the following thermosetting polymers with respect to synthesis, chemistry, properties and application.
- Mechanisms and reaction schemes of different polymerization techniques.

## Unit-IV: Polymer Synthesis (12 Hrs)

- Phenol – formaldehyde resins.
- Amino resins: Urea formaldehyde and melamine formaldehyde resins.
- Polyurethanes.
- Epoxy resins – Grades of epoxy resins curing process and its importance with mechanism.
- Elastomers – Poly isoprene, Poly butadiene, Neoprene.
- Detailed study of the following thermoplastic polymers with respect to synthesis, chemical properties and application.
- Poly olefins – Poly ethylene, HDPE, LDPE, LLDE, Polypropylene, Ethylene –
- Propylene co-polymer, PVC, Teflon, Polystyrene.
- Homo polymers, co-polymers such as SBR, ABS, SAN, Polyvinyl acetate andits modifications like PVA, PVB and poly acetals.

- Polyamides – Nylon-6, Nylone-66, and other Nylons.
- Poly ethers and polyesters – Tetraphthaletes, Polycarbonates.

**Unit-V: Polymer Processing (12 Hrs)**

- Polymer processing introduction
- Compounding
- Molding, Compression molding, Transfer molding, Injection molding, Extrusion molding, Blow molding
- Casting
- Drawing
- Rolling
- Applications of polymers

**Text books:**


1. Vasant R. Gowariker,2013 N. V. Viswanathan, JayadevSreedhar. Polymer Science, New Age International, 1986 – 11030.
2. Fred W Billmeyer, 2014, Textbook of polymer science, Wiley


**Reference Books:**


1. J.A. Brydson, Plastics Materials - (Seventh Edition), ISBN-9780750641326, Printbook , Release Date: 1999

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| 19UICCC203 | **Core Practical-3**<br>Surface Chemistry Practical | 03 hrs/wk | 01 Credits |

## Objectives:

1. Analyze colloidal nano-technological and chemical systems, processes and products
2. Use different theories to calculate surface and interfaces tensions and use this to estimate e.g. wetting and other system characteristics
3. Describe the conditions for stability of colloidal systems and discuss and compare different mechanisms for stabilization.
4. Understand the concept for stabilization of emulsions and foam, and design emulsions and foam.

## List of Experiments

1. To examine the effect of surfactant on surface tension of liquid.
2. To determine Surface Tension of liquids by drop number method. (Water, Toluene, Xylene, Hexane)
3. To prepare Colloidal solution of Oil and Water using Soap & Detergent.
4. To prepare dish wash liquid.
5. To prepare white phenyl.
6. To prepare glass cleaner.
7. To prepare hand wash liquid.
8. To study the adsorption of methylene blue in a solution using charcoal as adsorbent.
9. To Synthesize organic compound using Phase Transfer Catalyst (P.T.C.)
10. To electroplate Copper on a given object.
11. To determine the amount of Copper in Copper plating bath.
12. To determine the amount of Copper metal as a Copper Sulphide by gravimetrically method.

| 19UICCC204 | **Core Practical-4**<br>Polymer Chemistry & Technology Practical | 06 hrs/wk | 02 Credits |
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## Objectives:

1. Determine different polymers their properties and access them according to their industrial applications.
2. Study different polymerization techniques & their mechanisms.
3. Know Industrial polymer processing & their engineering aspects.

## List of Experiments:

**Polymer Preparation**

1. Prepare cellulose acetate from cellulose
2. Analyze physical properties of cellulose acetate.
3. Prepare Phenol Formaldehyde polymer.
4. Analyze physical properties of
5. Prepare glyptal resin from phallic anhydride.
6. Analyze physical properties of glyptal resin.
7. Prepare melamine formaldehyde copolymer.
8. Analyze physical properties of melamine formaldehyde.
9. Prepare urea formaldehyde copolymer.
10. Analyze physical properties of urea formaldehyde copolymer.

**Polymer Identification**

11. To identify given sample of polyethylene.
12. To identify given sample of polypropylene.
13. To identify given sample of polyvinyl chloride.
14. To identify given sample of polyvinyl acetate.
15. To identify given sample of Styrene acrylonitrile.
16. To identify given sample of Acrylobutadiene styrene.
17. To identify given sample of Nylon-6
18. To identify given sample of Nylon-6,6..
19. To identify given sample of polystyrene.
20. To identify given sample of Polyvinyl alcohol.

**B.Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-III**

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| 19UICCC301 | **CORE-5**<br>**UNIT OPERATIONS** | **05 HRS/WK** | **05 CREDITS** |

**OBJECTIVES:**

1. Carry out unit operations used in chemical industries.
2. Understand the working of equipment's of distillation, absorption, extraction, crystallization, filtration and centrifuge, drying and mixing.
3. Validate the concepts of heat exchange devices.

**UNIT-I: Distillation and Absorption (15 HRS)**

- **Distillation:** Introduction, Equilibrium or Flash Distillation, Batch or Differential Distillation, Steam Distillation, Continuous Distillation, Plate column and Packed Column, Separation of azeotropes, comparison between Distillation and Gas absorption
- **Absorption:** Introduction, Various type of tray for absorption column, Packed columns, Packing materials, Merits and Demerits of plate & packed tower, Selection of solvent for gas absorption, Mechanical Contactor

**UNIT-II: Extraction and Crystallization (15 HRS)**

- **Extraction:** Introduction, Selection of solvent for extraction, Equipment spray column & packed column for extraction, Mixer settler cascade, Rotating disc contactor
- **Crystallization:** Introduction, solubility, Super saturation, Nucleation, Crystal growth, The Mier's super saturation theory, Construction, Working, Merits and Demerits of following Equipment:

  Tank crystallizer, Swenson-Walker crystallizer, Circulating magma vacuum crystallizer, Oslo crystallizer.

**UNIT-III: Filtration and Centrifuge (15 HRS)**

- **Filtration:** Introduction, Filter media, Filter aids, classification of filtration, Construction, Working, Merits and Demerits of following Equipment:
  - Bed Filter/Sand filter,
  - Sparkler filter,
  - Rotary drum filter,
  - Nutch filter,
  - Nutrex Filter,
  - Bag filter,
  - Plate and frame filter,
  - Leaf filter.
- **Centrifuge:** Introduction, Construction, Working, Merits and Demerits of following Equipment:
  - Centrifuge,
  - Tubular bowl,
  - Disc bowl

**UNIT-IV: Drying (15 HRS)**

- Introduction, Free moisture, Bound moisture, Drying curve, Factors on which rate of drying depends, Classification of dryer.
- Construction, Working, Merits and Demerits of following Equipment:
  - Tray dryer,
  - Rotary dryer,
  - Flash dryer,
  - Fluidized bed dryer,
  - Drum dryer,
  - Spray dryer.

**UNIT-V: Mixing and Heat Exchanger (15 HRS)**

- **Mixing:** Introduction, Type of impellers used for mixing, Importance of baffle in mixing.
  Construction, Working, Merits and Demerits of following equipment:
  - Change-can mixer,
  - Ribbon blenders,
  - Internal Screw Mixers,
  - Tumbling mixers,
  - Kneader,
  - Dispersers & Masticators.
- **Heat Exchanger:** Introduction, Construction, Working, Merits and Demerits of following Equipments:
  - Double pipe heat exchanger,
  - Shell & tube heat exchanger,
  - Finned tube heat exchanger,
  - Plate type heat exchanger

**TEXT BOOKS:**


1. GavhaneK. A. (2009), "*Unit Operations-II (Heat and Mass Transfer operations)",* 23rd edition, NiraliPrakashan
2. TreybalR.E.(1981*), "Mass Transfer Operations"*, 3rd edition, McGraw Hill
3. McCabe & Smith (2001), "*Unit Operations in Chemical Engineering"*, 6th edition, McGraw Hall


**REFERENCE BOOKS:**


3. Sinnott R.K. (2010), "*Chemical EngineeringDesign",*5th edition, Elsevier, ISBN : 9380501161, 978-9380501161
4. Badger &Banchero(1998*), "Introduction to Chemical Engineering"*, 6th reprint, TMH
5. Foust et.el., (1994), "*Principles of Unit Operation",* 2nd edition: John Wiley
6. Warren Lee McCabe, Smith J., Harriott P.(2005), "*Unit Operations of Chemical Engineering",*McGraw Hill Education, ISBN: 0072848235, 9780072848236

**B.Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-III**

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| 19UICCC302 | **CORE-6**<br>**HEAVY CHEMICALS** | **04 HRS/WK** | **04 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 (12 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 (12 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 (12 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 (12 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

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**Unit-V: Important Heavy Chemicals-2 (12 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-III**

| 19UICCC303 | **CORE-7**<br>**MATERIAL SCIENCE** | **04 HRS/WK** | **04 CREDITS** |
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**OBJECTIVES:**

1. Understand mechanical properties of material.
2. Select material of construction according to its applications.
3. Check corrosion theories and its prevention techniques.

**UNIT-I: Mechanical Properties of Material (12 HRS)**

- Introduction of mechanical properties, various mechanical properties viz.
  - Elasticity,
  - Plasticity,
  - Toughness,
  - Resilience,
  - Tensile Strength,
  - Yield Strength,
  - Impact Strength,
  - Ductility,
  - Malleability,
  - Brittleness,
  - Hardness,
  - Fatigue,
  - Creep,
  - Wear Resistance,
- Factors affecting mechanical properties,
- Effects of low and high temperature on mechanical properties of metals.
- NDT-XRD Methods of Materials

**UNIT-II: Metals& Alloys (12 HRS)**

- Classification of metals and alloys, Purpose of alloying.
- Substitutional and interstitial alloys
- Properties of alloy
- Hume and Rothery rules for alloying.
  - Substitutional solid solution rules.
  - Interstitial solid solution rules

**UNIT-III: Iron, Copper and Shape-Memory Alloy (12 HRS)**

- Steel and Stainless steel, its classification, heat treatments, processing, properties and utilization.
- Copper and its alloys: Brass, Bronze, its classification, heat treatments, processing, properties and utilization
- Shape memory alloys: One-way memory effect, Two-way memory effect, Super elasticity, Manufacturing and applications.

**UNIT-IV: Composite Material** **(12 HRS)**

- Introduction, Classification of composite material.
- Particle-Reinforced Composites,
- Fibre-Reinforced Composites,
- Structural Composites,
- Application of composite material.

**UNIT-V: Heat Treatments of Materials** **(12 HRS)**

- Introduction of heat treatment
- Applications of heat treatment
- Types of heat treatments
  - Annealing
  - Normalizing
  - Stress relieving
  - Aging
  - Quenching
  - Tempering
  - Differential heat treatment
  - Differential hardening
  - Flame hardening
  - Cold and cryogenic treating

**TEXT BOOKS:**


1. NarulaG. K. (2007), 27th Reprint, "*Material Science"*, Tata McGraw-Hill Education, ISBN (0-07-451796-1)
2. Callister William D. Jr., *"Materials Science and Engineering, an Introduction"*, John Wiley & Sons, Inc, ISBN 978-0-471-73696-7.


**REFERENCE BOOKS:**


1. Milton Ohring (1995), "*Engineering Materials Science*", Volume 1, Academic Press Torrento, ISBN (0-12-524995-0).
2. WoleSoboyejo, 2003, "*Mechanical Properties of Engineered Materials"*, Marcel Dekker, Inc, ISBN (0-8247-8900-8).

**B.Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-III**

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| 19UICCC304 | **CORE PRACTICAL-5 UNIT OPERATIONS PRACTICAL** | **03 HRS/WK** | **01 CREDIT** |

**COURSE OBJECTIVE:**

1. Study unit operations used in various chemical industries
2. Understand the working of various equipment of unit operations
3. Learn the basic concept of various heat transfer devices

**LIST OF EXPERIMENTS:**

1. To find the percentage recovery of given sample by distillation technique.
2. To find the percentage recovery of given mixture of a solution by fractional distillation technique.
3. To determine the molecular condition of benzoic acid in kerosene and distilled water by the method of partition coefficient.
4. To determine the practical yield of organic compound like benzoic acid by cooling crystallization.
5. To determine the practical yield for inorganic compound like Copper Sulphate ($CuSO_4.5H_2O$) by evaporation.
6. To determine the practical yield for mixture of benzoic acid and copper sulphate sample by heating and cooling crystallization.
7. To determine the practical yield of crystallization of benzoic acid by with seeding and without seeding.
8. To determine the theoretical number of stages required for extracting acetic acid from its 10% solution of acetic acid in chloroform (50 ml) using water as solvent so as to limit its concentration in the final Raffinate to 0 % and % recovery of acetic acid from its mixture using calculated number of stages in multistage cross current extraction.
9. To determine partition co-efficient of chloroform in benzoic acid.
10. To perform steam distillation.

**B.Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-III**

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| 19UICCC305 | **CORE PRACTICAL-6 HEAVY CHEMICALS PRACTICAL** | **03 HRS/WK** | **01 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 Chlorine content in given hydrochloric acid.
2. To determine the Calcium content in given gypsum content.
3. To determine the Magnesium content in given sample.
4. To determine RI of different solvents by Abb's Refractometer.
5. To determine RI and unknown composition of given mixture of sample using A & B by Abb's Refractometer.
6. To determine Chlorine content in given common salt sample.
7. To scan absorption spectrum of clay and determine % transmission of different concentrated solution by Spectrophotometer.
8. To scan absorption spectrum of clay and determine wavelength of maximum absorption by Spectrophotometer.
9. To determine the Iron content in given sample.
10. To determine the Zinc content in given sample.

**B.Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-IV**

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| 19UICCC401 | **CORE-8**<br>**UNIT PROCESSES** | **04 HRS/WK** | **04 CREDITS** |

**OBJECTIVES:**

1. Study various unit processes in chemical industries
2. Understand the process flow diagram and various process parameters
3. Understand the manufacturing of various inorganic and organic chemicals

**UNIT-I: Sulphonation & Hydrolysis (12 HRS)**

- **Sulphonation:** Definition, Sulfonating agents, Chemical factors,Physical factors,Outline of chemical kinetic, mechanism and thermodynamics,
  Sulphonation process of:
  - Benzene,
  - Naphthalene,
  - Dodecyl benzene
- **Hydrolysis:** Definition, Hydrolysing agents, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics, Hydrolysis of starch

**UNIT-II: Oxidation & Hydrogenation (12 HRS)**

- **Oxidation:** Introduction, Types of oxidation reactions, Various oxidizing agents, Chemical factors, Physical factors, Outline of chemical kinetic, mechanism and thermodynamics,
  Manufacturing process, properties and uses of:
  - Acetic acid,
  - Acetaldehyde,
  - Benzoic acid,
  - Phthalicanhydride,
  - Maleic anhydride,
  - Acrolein.
- **Hydrogenation:**Introduction, Various methods of reduction, Chemical factors,Physical factors, Outline of chemical kinetic, mechanism and thermodynamics,Various hydrogenating catalyst,
  - Hydrogenation process of vegetable oils,
  - Synthesis process of methanol,
  - Reforming process.

**UNIT-III: Halogenation & Nitration (12 HRS)**

- **Halogenation:**Definition, Types of halogenation reactions, Various halogenating agents, Chemical factors, Physical factors,Outline of chemical kinetic, mechanism and thermodynamics,
  Manufacturing process, properties and uses of:
  - Mono Chloro acetic acid,
  - Sodium mono Chloro acetate,
  - Chloral,
  - Chlorobenzene,
  - Freon-12,
  - Chlorination of methane

- **Nitration:**Definition,Various nitrating agents,Chemical factors and Physical factors,Outline of chemical kinetic, mechanism and thermodynamics,Definition of : DVS, Nitric ratio
- Manufacturing process, properties and uses of:
  - Nitrobenzene,
  - m-dinitrobenzene,
- Nitration process of:
  - Chlorobenzene,
  - Acetanilide,
  - Toluene

**UNIT-IV: Alkylation & Esterification (12 HRS)**

- **Alkylation:**Definition, Types of alkylation reaction, Types of alkylating agents,Chemical factors and Physical factors, Outline of chemical kinetics, mechanism and thermodynamics,
  Manufacturing process, properties and uses of:
  - Alkyl aryl detergents,
  - Ethyl benzene,
  - Dimethyl aniline,
  - Phenyl ethyl alcohol
- **Esterification:**Definition,Types of Esterification reaction,Types of Esterification agents,Chemical factors and Physical factors,Outline of chemical kinetics, mechanism and thermodynamics,
  Manufacturing process, properties and uses of:
  - Cellulose acetate,
  - Vinyl acetate,
  - Ethyl acetate,
  - Dioctylphthalate

**UNIT-V: Amination and Ammoxidation (12 HRS)**

- **Amination by reduction:**Definition, Types of amination reaction, Aminating agents, Chemical factors and Physical factors, Outline of chemical kinetics, mechanism and thermodynamics,
  Manufacturing process, properties and uses of:
  - Aniline,
  - m-nitroaniline
- **Amination by ammonolysis:**Definition, Types of amination reaction, Aminating agents, Chemical factors and Physical factors, Outline of chemical kinetics, mechanism and thermodynamics.

**TEXT BOOKS:**


1. Narayanan C.M. and Bhattacharya B.C. (2016), "*Unit Operations and Unit Processes*: *Including Computer Programs",* Volume 2, 1st Edition, CBS:
2. GrogginsP. H., (1995), "*Unit Processes in Organic Synthesis"*, fourteenth reprint 2007, Tata Mcgraw-Hill


**REFERENCE BOOKS:**


1. Desikan and Sivakumar (Eds.) (1982), "*Unit Processes in Organic Chemical Industries"*, IITM
2. Austin G. T., (1988), "*Shreve's Chemical Process Industries",* 5th edition: New York : McGraw-Hill

**B. Sc. INDUSTRIAL CHEMISTRY**
**SEMESTER-IV**

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| 19UICCC402 | **CORE-9**<br>**FINE CHEMICALS** | **04 HRS/WK** | **04 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: (12 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 (12 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 (12 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 **(12 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: (12 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 (AUTONOMOUS)**
**SEMESTER-IV**

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| 19UICCC403 | **CORE-10**<br>**MASS & ENERGY BALANCE** | **04 HRS./WK.** | **04 CREDITS** |

**OBJECTIVES:**

1. Apply concepts of unit operations and unit processes for chemical industries.
2. Solve calculations of material and energy balance in the processes.
3. Execute idea of proportion of feed and products/by products by doing mass balance.

**UNIT-I: Fundamentals of Mass and Energy Balance (12 HRS)**

- Fundamental quantities, Derived quantities, Dimensions and System of Unit, Conversions of units, Basis of calculation, Atomic weight, Molecular weight, Equivalent weight, Molarity, Normality, Molality, Methods of expression, Composition of mixtures and solutions, Mole fraction, Weight fraction, Energy, Latent heat, Sensible heat, Heat capacity.

**UNIT-II: Mass Balance without Chemical Reaction – 1 (12 HRS)**

- Outlines of procedure for material balance, Calculation by using various operations carried out in industry: their significance and block diagrams of distillation, evaporation, adsorption, extraction and drying.

**UNIT-III: Mass Balance without Chemical Reaction – 2 (12 HRS)**

- Outlines of procedure for material balance, Calculation by using various operations carried out in industry: their significance and block diagrams of filtration, mixing, dissolution and crystallization.

**UNIT-IV: Mass Balance Involving Chemical Reactions (12 HRS)**

- Definitions of terms involved, Stoichiometry, Limiting reactants/components, Excess reactants, Conversion, Yield and selectivity, Liquid phase reactions, Gas phase reactions with/without recycle or bypass.

**UNIT-V: Energy Balance (12 HRS)**

- Forms of energy, common unit of thermal energy, Law of conservation of Energy, Flow process, Non flow process, General Energy balance procedures, Standard heat of formation, reaction and combustion, Heat capacity of pure gases and gaseous mixtures at constant pressure, Relation between $C_p$ and $C_v$, Hess law of Constant heat Summation, Phase changes and Enthalpy changes accompanying chemical reactions and their examples.

**TEXT BOOKS:**


1. GavhaneK.A., (2012), "*Introduction to Process Calculations (Stoichiometry)"*, Volume-2:NiraliPrakashan,ISBN: 8190639668.
2. OlomanColin,(2009), "*Material and Energy Balances for Engineers and Environmentalists"*, Volume 1:University of British Columbia, Canada ISBN 1-84816-368-1

**REFERENCE BOOKS:**


1. Narayanan K. V. Lakshmikutty(2006), "*Stoichiometry And Process Calculations"*, PHI Learning Pvt. Ltd., 1st edition: New Delhi, ISBN 10: 8120329929
2. IgbinogheneDavid Carr , (2004), "*Chemical Process Calculations"*, McGraw-Hill, ISBN-10: 0071438408
3. Schlesinger Mark A. (2010), "*Mass and Energy Balances in Materials Engineering",*1st edition: Prentice Hall, ISBN.0024073865

| 19UICCC404 | **CORE PRACTICAL-7<br>UNIT PROCESSES PRACTICAL** | **06 HRS./WK.** | **02 CREDITS** |
|---|---|---|---|

**COURSE OBJECTIVE:**

1. Study various unit processes in chemical industries
2. Understand the process flow diagram and various process parameters
3. Understand the manufacturing of various inorganic and organic chemicals

**LIST OF EXPERIMENTS**

1. Preparation of Fumaric acid from Maleic acid.
2. Preparation of Benzil from Benzoin.
3. Preparation of m-nitro benzoic acid from Benzoic acid.
4. Preparation of p-nitro benzoic acid from p-nitro toluene.
5. Preparation of Diazo amino benzene from Aniline.
6. Preparation of Phenyl azoβ-Naphthol from Aniline.
7. Preparation of p-bromo acetanilide from Acetanilide.
8. Preparation of α-Nitro naphthalene from Naphthalene.
9. Preparation of p-bromo aniline from p-bromo acetanilide.
10. Preparation of p-nitro aniline from p-nitro acetanilide.
11. Preparation of Sulfanilic acid from Aniline.

| 19UICCC405 | **CORE PRACTICAL - 8 FINE CHEMICALS PRACTICAL** | **03 HRS/WK** | **01 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 raw materials.

**Practical**

**1.** To determine amount of Benzoic acid in given sample.
**2.** To determine the amount of Glucose by Iodometry.
**3.** To determine purity of Hydrogen peroxide in 6% w/v $H_2O_2$ solution.
**4.** To determine % purity of Hydrogen borate.
**5.** To determine the amount of Dextrose in given sample by Iodometry.
**6.** To determine the % of washing soda using $Na_2CO_3$ powder.
**7.** To determine the % of washing soda using Detergent.
**8.** To determine free fatty acid in given oil sample.
**9.** To determine angle of rotation of Sucrose by Polarimeter.
10. To determine angle of rotation of Tartaric acid by Polarimeter.

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-V**

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|---|---|---|---|
| 19UICCC501 | **Core-11**<br>PRINCIPLES OF CHEMICAL ENGINEERING-I | 05 hrs/wk | 05 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** **(15 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** **(15 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** **(15 HRS)**

- 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** **(15 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** **(15 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**

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|---|---|---|---|
| 19UICCC502 | **Core-12**<br>DYES & PIGMENTS | 04 hrs/wk | 04 Credits |

**OBJECTIVES:**

1. Understand the difference between dyes, pigments and paints.
2. Synthesize various dyes and intermediates.
3. Formulations of various paints and pigments.

**UNIT-I: Introduction: Dyes (12 HRS)**

- Dyes – Introduction – Classification – Ancient and Modern theories based on Color and chemical constitution of dyes.
- Various attraction forces exist between dyes and substrate. Different reason based on ancient theories.
- Optical Whiteners, Fluorescent brightener's and Fastness properties on various parameters. `

**UNIT-II: Dye's Intermediate (12 HRS)**

- Benzene Intermediates: Chlorobenzene & Nitrobenzene, Nitro anilines, Toluene and Xylene intermediates.
- Naphthalene Intermediates: H-acid, J-acid, R-acid, NW-acid, Chicago acid, Schaffer's acid, Naphthol, NaphtholSulphonic acid, Naphthyl amine sulfonic acids.
- Anthraquinone Intermediates: 1-Amino Anthraquinone, 2-Amino Anthraquinone, Bromamine acid and Quinazarin.

**UNIT-III: Azo Dyes (12 HRS)**

- Introduction - Classification - Various methods of Diazotizations.
- Sub-classes of Azo Dyes:- Mono azo, Bisazo, Trisazo and Poly azo dyes
- Mono azoAcid Dyes:- Acid Orange II, Acid Orange IV.
- Mono azo Mordant Dyes:-Eriochrome Black A, Eriochrome Black T, Eriochrome Red B.
- Mono azo Basis Dyes:- Aniline Yellow, Butter Yellow, Chrysodine G, Bismark Brown, Congo Red, Benzopurpurin, Rosanthrene O.
- Study of dyes like Direct Black EW, Brilliant Yellow, Metanil Yellow, Naphthol Blue Black 6B, Tartrazine.

**UNIT-IV: Indigoid, Reactive and Vat (Anthraquinone) Dyes (12 HRS)**

- Introduction to Indigoid dyes, Synthesis of Indigo, Indigosol O and Thio-indigo.
- Introduction to Reactive dyes, Synthesis of Reactive red, Procion Red dye, Procion Blue HB
- Introduction to Anthraquinone Vat dyes, Synthesis of Indanthrene yellow 4GK, Indanthrone Blue,Flavanthrone, Pyranthrone, Indanthrene Brown RRD, Indanthrene Rubene R.

**UNIT-V: Pigments & Paints (12 HRS)**

- Pigments – Introduction - Requirements of organic pigments - Types of Pigments – Applications – Special effect pigments
- Paints – Introduction – Requirements of paints – Types of paints – applications – Paint additives and solvents – Basics of paint formulations – Manufacture of powder coating, dry distempers, cement paints, oil and water based distempers and paints.

**TEXT BOOKS:**


1. Sharma, B. K. (2011), "*Industrial chemistry"*, 16th Edition, India: Krishna Prakashan Media (P) Ltd., ISBN-13: 978-81-8283-120-9
2. Dr. H. Panda (2016), "*Modern technology of textile dyes and pigments"*, Vol. 1, NIIR Board. ISBN: 9789381039717
3. NIIR Board (2004), "*The complete technology book on Dyes and Dyes intermediates"*, Vol. 1, National Institute of Industrial Research publication. ISBN: 8186623795
4. Waring, David R., Hallas, Geoffrey, (1990),"*The Chemistry and Application of Dyes",* Plenum Press, New York. ISBN: 978-1-4684-7715-3


**REFERENCE BOOKS:**


1. Venkataraman K. (1965), "*The chemistry of synthetic dyes"*,Vol.1, Academic Press Publication, ISBN: 10:0127170014
2. Venkataraman K. (1965), "*The chemistry of synthetic dyes and pigments"*,Vol.1, Academic Press Publication, ISBN: 9780323142953
3. Venkataraman K. (1973), "*The chemistry of synthetic dyes – Reactive Dyes"*,Vol.6, Academic Press Publication, ISBN: 0127170065
4. Chatwal G. R., "*Synthetic Dyes"*, Himalaya Publishing House, ISBN: 1234567143898
5. Rangnekar D. M. and Singh P. P., "*An introduction to Synthetic dyes"*, Himalaya Publication, Bombay
6. Venkataraman K., Viley John.,"*The analytical chemistry of synthetic dyes"*, New York.
7. Finar I. L.(1963-64), "*Organic chemistry",* volume – *I, II*, 3rd and 4th edition Longmans

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-V**

| | | | |
|---|---|---|---|
| 19UICCC503 | **Core-13**<br>INDUSTRIAL UTILITIES<br>(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** **(02 HRS)**

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

**Unit-II: Water** **(03 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** **(03 HRS)**

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

**Unit-IV: Compressed Air** **(03 HRS)**

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

**Unit-V: Steam, Steam Generation and Steam Distribution (04 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**

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|---|---|---|---|
| 19UICDC501 | **DSE Core Elective-1**<br>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 (12HRS)**

- 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. (12 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 (12 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 (12 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 (12 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**

| | | | |
|---|---|---|---|
| 19UICDC502 | **DSE Core Elective-1**<br>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 based quantitative risk analysis.
4. 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

**Unit-I: General Industrial Hazards & Process Safety (12 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 (12 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, and Blow down Systems, Flare Systems, Flame arresters, Deflagration arresters and Explosion suppression, Personal Safety Devices.

**Unit-III: GLP & GMP & Safety standards (12 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 (12 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 (12 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**

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|---|---|---|---|
| 19UICCC504 | **Core Practical-9**<br>PRINCIPLES OF CHEMICAL ENGINEERING PRACTICAL | 03 hrs/wk | 01 Credit |

**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**

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|---|---|---|---|
| 19UICCC505 | **Core Practical-10**<br>DYES & PIGMENTS PRACTICAL | 06 hrs/wk | 02 Credit |

**OBJECTIVES:**

1. Preparation of azo dyes
2. Carry out cotton dyeing.

**LIST OF PRACTICAL FOR DYES PREPARATION:**

1. To prepare Lake Red dye
2. To prepare Yellow 4G dye
3. To prepare Methyl Orange dye
4. To prepare Mordant Yellow dye
5. To prepare Methyl Red dye
6. To prepare Fast Green O

**LIST OF PRACTICAL FOR COTTON DYEING:**

1. Dyeing of a cotton piece by Crystal Violet
2. Dyeing of a cotton piece by Methylene Blue
3. Dyeing of a cotton piece by Congo Red
4. Dyeing of a cotton piece by Aniline Black

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-V**

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|---|---|---|---|
| 19UICDC503 | **DSE Core Elective Practical-1**<br>PETROLEUM ANALYSIS PRACTICAL | 03 hrs/wk | 01 Credit |

**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**

| | | | |
|---|---|---|---|
| 19UICDC504 | **DSE Core Elective Practical-1**<br>INDUSTRIAL SAFETY PRACTICAL | 03 hrs/wk | 01 Credit |

**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**

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|---|---|---|---|
| 19UICCC506 | **Core-14**<br>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** |
|---|---|
| 19UICCC01 | Industrial Instrumentations |
| 19UICCC02 | Renewable & Non-Renewable Sources |
| 19UICCC05 | Surface Chemistry |
| 19UICCC06 | Polymer Science & Technology |
| 19UICCC09 | Unit Operations |
| 19UICCC10 | Heavy Chemicals |
| 19UICCC11 | Material Science |
| 19UICCC14 | Unit Processes |
| 19UICCC15 | Fine Chemicals |
| 19UICCC16 | Mass & Energy Balance |
| 19UICCC19 | Principles Of Chemical Engineering-I |
| 19UICCC20 | Dyes & Pigments |
| 19UICCC21 | Industrial Utilities (Self Study) |
| 19UICDC01 | Petroleum & Petrochemicals |
| 19UICDC02 | Industrial Safety |

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-VI**

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|---|---|---|---|
| 19UICCC601 | **Core-15**<br>PRINCIPLES OF CHEMICAL ENGINEERING-II | 04 hrs/wk | 04 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 (12 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 (12 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 (12 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** **(12 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** **(12 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**

| | | | |
|---|---|---|---|
| 19UICCC602 | **Core-16**<br>ANALYTICAL CHEMICAL TECHNIQUE | 04 hrs/wk | 04 Credits |

**OBJECTIVES:**

1. Understand principles and applications of modern chemical instrumentations.
2. Determine chemical and physical of instrumental methods of analysis, including different types of spectroscopy, sampling techniques, chemical separation methods and mass spectrometry.
3. Develop skill in formulating and troubleshooting in mass spectrometry, infrared and NMR spectroscopy.

**UNIT-I: Analytical Analysis Methods (12 HRS)**

- Introduction, principle, various factors, measurement, application, importance apparatus of following analysis methods:
  - Conductometric titration
  - pH metric methods
  - Potentiometric titrations
  - Refractometry
  - Colorimetric analysis
  - Spectrophotometer
  - Polarimetric analysis.

**UNIT-II: Sampling Procedures of Solid, Liquid And Gas (12 HRS)**

- The basis of sampling, Sampling procedure, Sampling and physical state, crushing and grinding, Sampling procedures, sampling of bulk materials, techniques of sampling for solids, Liquids and gases, Hazards in sampling

**UNIT-III: Traditional Chemical Techniques (12 HRS)**

- Introduction, basic theory of chromatography, classification of chromatographic techniques, Adsorption and partition, Rate theory, selection of stationary and mobile phase, Thin layer chromatography (TLC), Paper Chromatography (PC)

**UNIT-IV: Modern Analytical Techniques (12 HRS)**

- Sophisticated Chromatographic techniques like Gas chromatography (GC) and Liquid chromatography (LC), Comparison between various types of Detectors used in Chromatography, Flame Ionization detector (FID), Electron capture detectors (ECD), Thermal conductivity detector (TCD)

**UNIT-V: Spectrometric Techniques (12 HRS)**

- Principle, construction, working and Specific applications of UV visible spectroscopy, IR spectroscopy, NMR spectroscopy and Mass Spectroscopy.

**Text Book**


1. Sharma B., (2000), "*Chemical Instrument analysis"*, Krishna Prakashan media publisher (ISBN: 8182830192, 9788182830196)
2. Vogel A., G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, (1989), "*Quantitative chemical analysis"*, Longman publisher (ISBN: 9788177581805)
3. D. Skoog and J. Leary, (1992), "*Principles of Instrumental analysis"*, Saunders College publishers (ISBN: 978-0495012016)


**Reference Book**


1. Braun R.D., (1987), "*Introduction to Instrumental analysis"*, McGraw-Hill College (ISBN-10: 0070072914)
2. Rick J. G., (1999), "*Analytical Chemistry"*, McGraw-Hill Publication Co.

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-VI**

| | | | |
|---|---|---|---|
| 19UICCC603 | **Core-17**<br>PHARMACEUTICALS | 04h Hrs/wk | 04 Credit |

**Unit-I: Pharmacopoeia & Dosage Forms (12 HRS)**

- 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 (12 HRS)**

- 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 (12 HRS)**

- Introduction and study of various bulk drugs like:
  - Anaesthetic agent: Benzocaine, Lignocaine.
  - Sulpha drugs: Sulpha guanidine, Sulpha methoxazole, Sulphathiazole, Sulphadoxine, Sulphacetamide
  - Analgesics, Antipyretic and Anti-inflammatory: Aspirin, Methyl salicylate, Paracetamol, Phenacetin, Mefenic acid, etc.
  - Barbiturates: Phenobarbitol, Pentobarbitol, Talbutal, Butalbital, etc.
  - Anti-hypertensive & Cardiovascular Agents: Methyldopa, β-blockers: Propanolol, Atenolol, etc.
  - Antimicrobials: Isoniazid, PAS, etc.

**Unit-IV: Industrial Microbiology (12 HRS)**

- 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 (12 HRS)**

- 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, Vitamins, 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**

| | | | |
|---|---|---|---|
| 19UICDC601 | **DSE Core Elective-2**<br>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. (12 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. (12 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. (12 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. (12 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 (12 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:**

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

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-VI**

| | | | |
|---|---|---|---|
| 19UICDC602 | **DSE Core Elective-2**<br>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 (12 HRS)**

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

**Unit-II: Steroids (12 HRS)**

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

**Unit-III: Terpenoids (12 HRS)**

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

**Unit-IV: Vitamins (12 HRS)**

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

**Unit-V: Alkaloids** **(12 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**

| | | | |
|---|---|---|---|
| 19UICCC604 | **Core Practical-11**<br>ANALYTICAL CHEMICAL TECHNIQUE PRACTICAL | 06 hrs/wk | 02 Credits |

**OBJECTIVES:**

1. Understand principle, construction, working and applications of analytical chemical instrumentations
2. Quantify various metals in sample using analytical instrumentations
3. Determine Normality, hardness of water and pH of sample using various analytical techniques.

**EXPERIMENT LIST:**

1. Determination the amount of non-volatile dissolved solids in the given sample of water.
2. Determination of alkalinity of water sample in terms of carbonate, bicarbonate and hydroxide.
3. Determination of amount of chloride in given water sample.
4. Determination of hardness of a water sample.
5. Determination of the total acidity of the given water sample.
6. Determination of the normality of X-N $CH_3COOH$ solution with the help of 0.5 N NaOH solution by using Conductivity meter.
7. Determination of the normality of X-N HCl solution with the help of 0.5 N NaOH solution by using Conductivity meter.
8. Determination of the normality of X-N HCl +$CH_3COOH$ solution with the help of 0.5 N NaOH solution by using Conductivity meter.
9. Determination of the normality of X-N $CH_3COOH$ solution with the help of 0.5 N NaOH solution by using pH meter.
10. Determination of the normality of X-N HCl solution with the help of 0.5 N NaOH solution by using pH meter.
11. Determination of the normality of X-N $CH_3COOH$ solution with the help of 0.5 N NaOH solution by using Potentiometer.
12. Determination of the normality of X-N HCl solution with the help of 0.5 N NaOH solution by using Potentiometer.
13. Determination of the amount of Nickel with the dimethyl glyoxime.
14. Determination of the amount of $Fe^{+3}$ present in given sample.
15. Determination of the amount of $NO_2^{-1}$ present in given sample.
16. Determination of the % concentration of given solution of Glucose on basis of angle of rotation by using Polarimeter.

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-VI**

| | | | |
|---|---|---|---|
| 19UICCC605 | **Core Practical-12**<br>PHARMACEUTICALS PRACTICAL | 03 hrs/wk | 01 Credit |

**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
5. To prepare Benzilic acid from benzil

**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 Cephalaxin from the given sample.
5. Estimation of Antacid from the given sample

**B.SC. INDUSTRIAL CHEMISTRY**
**SEMESTER-VI**

| | | | |
|---|---|---|---|
| 19UICDC603 | **DSE Core Elective Practical-2**<br>INDUSTRIAL MANAGEMENT PRACTICAL | 03 hrs/wk | 01 Credit |

**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**

| | | | |
|---|---|---|---|
| 19UICDC604 | **DSE Core Elective Practical-2**<br>CHEMISTRY OF NATURAL PRODUCTS PRACTICAL | 03 hrs/wk | 01 Credit |

**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.