SAURSHTRA UNIVERSITY

ACCREDITED GRADE "A" BY NAAC
(CGPA 3.05)

COURSE DETAILS OF

Master of Science

SEMESTER – I
PAPER: MS-IC-101 (CBCS)
&
SEMESTER – II
PAPER: MS-IC-201 (CBCS)

INDUSTRIAL CHEMISTRY

(In Force from June – 2016)

CONTENTS

Master of Science
in
Industrial Chemistry

CBCS- Semester - 1 **(T & P)**

MSIC – 101

INDUSTRIAL STOICHIOMETRY & MOMENTUM TRANSFER OPERATION

UNIT- 1 INDUSTRIAL STOICHIOMETRY (WITH CHEMICAL REACTION):

Material and Energy balance calculation for processes with chemical reactions recycle purge and by-pass operations, batch and continuous operations.

UNIT- 2 INDUSTRIAL STOICHIOMETRY (WITHOUT CHEMICAL REACTION):

Material and Energy balance calculation for processes without chemical reactions recycle purge and by-pass operations, batch and continuous operations.

UNIT- 3 TRANSPORTATION OF FLUIDS:

Boundary layer concept, Calculations for reciprocating and centrifugal pumps, Use of air vessels in pumps, Vapor locking and NPSH. Design of Flow meters, Pressure and Vacuum producing devices

UNIT- 4 MOMENTUM TRANSFER OPERATIONS

Dimensionless analysis using Rayleigh's and Buckingham II method, Motion of particles through fluids: Terminal settling velocity of particles settling under Stokes, Intermediate and Newton's range in free & hindered settling, Mechanism of fluidization, Design of fluidized bed columns.

REFERENCE BOOKS:

1. Stoichiometry, H.T. Bhatt, S.M. Vora, Tata Mc Graw Hill. Co.
2. Fundamentals of Engg. Heat & Mass Transfer, R.C. Sachieve, Wiley Ltd.
3. Basic Principles and Calculations in Chemical Engg. D.Himel Blan, Prentice Hall.
4. Chemical Process Principles, Vol. I. Houghen, Watson, Asian Pub. House.

MSIC – 102

INDUSTRIAL UNIT OPERATIONS

UNIT- 1 MASS TRANSFER UNIT OPERATIONS:

Local and Overall Mass Transfer co-efficient:

Gas Absorption: Choice of solvent for absorption, Minimum Liquid – gas ratio for absorbers, HETP in continuous contact equipments.

Distillation: Use of McCabe Thiele method in the design of multistage tray towers, q-line equation, Effect of reflux ratio.

Liquid Extraction: Choice of solvent for extraction Binodal solubility curves, Calculations for single stage and multi stage cross & countercurrent extraction.

UNIT- 2 MASS TRANSFER:

Drying: Rate of batch drying, Calculations for cross and through circulation drying, Rate of drying for continuous driers, Hold up in rotary driers.

Filtration: Theory of Filtration, Filtration, Filtration in centrifuges.

UNIT- 3 HEAT TRANSFER - CONDUCTION:

Local and Overall heat transfer co-efficient: Introduction to thermal diffusivity. Three Dimensional heat conduction equations in rectangular and cylindrical co-ordinates, Effect of variable thermal conductivity, Heat transfer from extended surfaces.

UNIT- 4 HEAT TRANSFER – CONVECTION & RADIATION:

Free and Forced Convection Calculation involving convection mode of heat transfer in rectangular & cylindrical surfaces. Dropwise and film condensation, Terminologies in radiation mode of Application for Planck's distribution law, Stefan Boltzmann Law and Kirchhoff's law, Radiation Shields, LMTD correction factors, Design of single and multi-pass exchangers, Effectiveness and number of transfer units for heat exchangers.

REFERENCE BOOKS:

1. Engineering Heat Transfer, C.P. Gupta, R. Prakash, Nomchand & Bros, Roorkee.
2. Mass Transfer Operations, Robert Treybal, Mc. Graw Hill Co.
3. Unit Operations of Chemical Engineering, W.Mc. Cabe, J. Smith, Mc. Graw Hill Co.
4. Chemical Engineering, Vol. I to VI, Coulson & Richardson, Pergamon Press.
5. Process Heat Transfer, D.Q. Kern, Mc. Graw Hill Co.

MSIC – 103

INDUSTRIAL UNIT PROCESSES & REAGENTS

UNIT- 1 HALOGENATION, ALKYLATION & ACYLATION

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing using following Unit processes: **Halogenation, Alkylation & Acylation**

UNIT- 2 OXIDATION, HYDROGENATION & REDUCTION

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing using following Unit processes: **Oxidation, Hydrogenation & Reduction**

UNIT- 3 NITRATION, SULPHONATION & ESTERIFICATION

Principle, Reagents, Mechanism, Kinetics, Applications involving Industrial Product manufacturing using following Unit processes: **Nitration, Sulphonation & Esterification**

UNIT- 4 REAGENTS

Preparation, Properties, Mechanism of Action & Applications involving name reaction or rearrangement of following Reagents:

$LiAlH_4$
Diethylazodicarboxylate (DEAD)
N.B.S.
Sodamide
Dicyclohexylcarbodiimide (DCC)
Sodamide
Triphenyl Phosphene
Lead tetra acetate

REFERENCE BOOKS:

1. Organic reaction and reagent by O.P. Agrawal.
2. Unit Process in organic Synthesis, Groggins.
3. Chemistry of Petrochemicals Process, Sami Mater, Levis Hatch, Gulf Professional Pub.
4. Industrial organic Chemistry, K. Weissermal, H.J. Arpe, Wiley VCH.
5. Organic Chemistry, Vol. I, I.L. Finar, Longman Scientific.
6. Advanced Organic chemistry, J. March.
7. Art of Writing reasonable organic reaction mechanism, Robert Grossman, Springer Verlag.
8. Organic Chemistry, Graham Solomon, G. Fryhle Wiley & Sons.

MSIC – 104

ORGANIC SYNTHESIS & DISCONNECTION APPROACH

REACTIVE INTERMEDIATES IN ORGANIC SYNTHESIS:

UNIT- 1 FREE RADICALS, CARBOCATION, CARBANIONS & NITRENE

Introduction, Formation, Stability and **TWO** name Reactions & **TWO** Rearrangements involving following intermediates: **Free radicals, Carbocation, Carbanions & Nitrene**

Intermediates	Name reactions	Rearrangements
Free radicals	Birch Reduction	Claisen
	Grignard Reaction	Cope
Carbocation	Baeyer-Villiger Oxidation	Pinacol- pinacolone
	Vilsmeier-Haack	Benzilic acid
	-	Fries
Carbanions	Junjappa-Ila Annulation & Heteroannulation	Favorskii
	Dieckmann	Stevens
Carbenes	Arndt-Eistert	Wolff
	Reimer-Tiemann	-

UNIT- 2 ENAMINES, CARBENES, PHOSPHORUS YLIDES & BENZYNE

Introduction, Formation, Stability and **TWO** name Reactions & **TWO** Rearrangements involving following intermediates: **Enamines, Carbenes, Phosphorus ylides & Benzyne**

Intermediates	Name reactions	Rearrangements
Phosphorus ylides	Mitsunobu reaction	1,2-Wittig
	Wittig	Schlosser
	Apple	-
Nitrenes	Hofmann Bormamide	Curtius
	Schmidt	Lossen
	-	Backmann
Enamines	Mannich	-
	Pictet–Spengler	-
	Storke Enamines	-
Benzyne	Diels Alder	-

DISCONNECTION APPROACH:

UNIT- 3 DISCONNECTION APPROACH STRATEGY 1 & 2

Basic principle: Synthesis of Aromatic Compounds. Strategy I: The order of events. One group C-X disconnections, Strategy II: Chemo selectivity

UNIT- 4 DISCONNECTION APPROACH STRATEGY 3 & 4

Strategy III: Reversal of Polarity, Cyclisation reaction, Strategy IV: Protecting groups, one group C-C disconnection: Alcohols and Carbonyl compounds

REFERENCE BOOKS:

1. A Textbook of Organic Chemistry, R.K.Bansal
2. Organic Reaction Mechanism, V.K.Ahluwalia
3. Organic Chemistry, Vol. I, I.L. Finar, Longman Scientific.
4. Advanced organic chemistry, J. March.
5. Art of Writing reasonable organic reaction mechanism, Robert Grossman
6. Organic Chemistry, Graham Solomons, G.Fryhle Wiley & Sons.
7. Organic Synthesis – The disconnection approach by Stuart Warren, Willey

MSICP – 105

LABORATORY COURSE (SEM. - I)

Paper No.	Title	Experiments Based on following*
MSIC – 101	Industrial Stoichiometry & Momentum Transfer Operation	• Fluid Mechanics
MSIC – 102	Industrial Unit Operations	• Heat Transfer • LLE
MSIC – 103	Industrial Unit Processes & Reagents	• Unit Processes • Organic Synthesis
MSIC – 104	Organic Synthesis & Disconnection Approach	

* Details to be worked out by the Department.

LIST OF PRACTICAL

FLUID MECHANICS

1. To determine the Reynolds number for flowing fluid using a Closed Circuit Reynolds Apparatus.
2. To determine the coefficient of discharge for a flow meter using closed circuit venturimeter and orifice meter apparatus.
3. To verify Bernoulli's theorem using Bernoulli's apparatus.
4. To calculate and study the energy losses in pipe fittings such as sudden contraction, sudden enlargement, bends & elbows and to determine flow through a Rotameter.
5. To calculate and study the energy loss due to pipe friction.
6. To determine coefficient of discharge C_d for notches and weirs of different shapes.

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Closed circuit Notches & Wiers apparatus
2. Closed circuit Pipe Fitting & Rotameter apparatus
3. Closed circuit pipe friction apparatus
4. Closed circuit Bernoulli's Theorem apparatus
5. Closed circuit Reynolds apparatus
6. Closed circuit Venturimeter & Orifice apparatus

HEAT TRANSFER OPERATIONS

1. To find the critical radius of insulation thickness on a cylinder.
2. To determine the Emissivity measurement of grey surface at different temperatures.

3 To find out heat transfer coefficient and heat transfer rate from vertical in natural convection and to find emissivity of the cylinder surface.

4 To determine the Thermal conductivity of insulating powder (Asbestos) at various heat inputs.

5 To determine the thermal conductivity of poor conducting material, say asbestos sheet.

6 To determine the overall heat transfer coefficient of the composite wall & compare the same with that calculated from the equation.

7 To study and compare temperature distribution, heat transfer rate, overall heat transfer coefficient in parallel flow and counter flow heat exchanger.

8 To determine the value of Stefan Boltzmann constant for radiation heat transfer.

9 To plot the radial temperature distribution and to determine the thermal conductivity of pipe insulation.

10 To determine the thermal conductivity of a good conductor material, any brass.

11 To determine the variation of temperature along the length of pin fin under forced convection.
To determine the values of heat transfer coefficient under forced condition and to find theoretical values of temperature along the length of fin and effectiveness and efficiency of the pin-fin for insulated and boundary condition.

12 To determine and compare surface heat transfer coefficient for
a) drop wise condensation & b) film wise condensation

13 To determine the average theoretical and experimental value of coefficient of heat transfer for forced convection for the fluid flowing through a pipe.

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Emissivity measurement apparatus
2. Heat transfer in forced convection apparatus
3. Thermal conductivity of insulating powder apparatus
4. Heat transfer in natural convection apparatus
5. Thermal conductivity of composite wall apparatus
6. Thermal conductivity of guarded hot plate apparatus
7. Thermal conductivity of metal bar apparatus
8. Stefen Boltzman apparatus
9. Heat transfer from Pin-fin apparatus
10. Critical radius of insulating material apparatus
11. Heat transfer through Lagged pipe apparatus
12. Dropwise and Filmwise condensation apparatus
13. Parallel flow/Counter flow Heat Exchanger apparatus

LIQUID LIQUID EXTRACTION (LLE)

1. To determine the distribution coefficients of carbon tetra chloride solvent for 20% aqueous acetic acid solution
2. To determine the distribution coefficients of Ethyl Acetate solvent for 20% aqueous acetic acid solution
3. To determine the distribution coefficients of Benzene solvent for 20% aqueous acetic acid solution
4. To develop solubility curve for the Ternary System Water(A) –CTC (B)-Acetic Acid(C)
5. To develop solubility curve for the Ternary System Water(A) –$CHCl_3$ (B)-Acetic Acid(C)
6. To develop solubility curve for the Ternary System Water(A) –Benzene (B)-Acetic Acid(C)
7. 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 almost zero **%** and % recovery of acetic acid from its mixture using calculated number of stages in multistage cross current extraction
8. To determine the quantity of Oil Present in a Oil Bearing Material.

LIST OF EQUIPMENTS/INSTRUMENTS/GLASSWARES:

1. Soxhlet assembly
2. Separating Funnel
3. Titration assembly

ORGANIC SYNTHESIS & UNIT PROCESSES

1. To prepare Benzilic acid from Benzil (Benzil-Benzilic acid rearrangement)
2. To Prepare Hippuric acid from Glycine. (Benzoylation)
3. To Prepare Phenylurea from Aniline.
4. To Prepare 3-Methyl-1-phenyl-5-pyrazolone from Ethyl acetoacetate. (Cyclization)
5. To Prepare Resacetophenone from Resorcinol.
6. To Prepare m-Nitroaniline from m-Dinitrobenzene (Selective Reduction)
7. To Prepare p-Bromoacetanilide from Acetanilide (Bromination)
8. To prepare Acetanilide from Aniline (N-Acetylation)
9. To Prepare p-Bromo aniline from p-Bromoacetanilide (Hydrolysis)
10. To prepare p-Nitro acetanilide from Acetanilide (Nitration)
11. To Prepare p-Bromonitrobenzene from Bromobenzene (Nitration)
12. To Prepare p-Nitroaniline from p-Nitroacetanilide (Hydrolysis)
13. To prepare t-Butylchlrode from t-Butanol (Functional Grp Conv. Chlorination)

14. To Prepare Benzaldine aniline (Schiff Base) from Aniline. (Solvent free reaction)
15. To prepare Benzalacetophenone (Chalcone) from Acetophenone. (Carbanion)

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Hot air Oven
2. UV Chamber
3. Weighing balance
4. Desiccator
5. Distillation assembly etc…
6. RBF assembly etc...
7. Waterbath, Oilbath, Sand bath.
8. Thermometer

Master of Science
in
Industrial Chemistry

CBCS- SEMESTER - 2 (T & P)

MSIC – 201

CHEMICAL REACTION ENGINEERING

UNIT- 1 FUNDAMENTALS OF REACTION ENGINEERING

Factors affecting reactor designing, Single and multiple Reactions, Elementary and Non-elementary reactions, Catalyzed and non-catalyzed reactions.

UNIT- 2 KINETICS OF HOMOGENEOUS REACTIONS

Molecularity and order of reactions, Kinetic Models for non-elementary reactions, Temperature dependency and reaction rate prediction from Arrhenius, transition and collision theories.

UNIT- 3 DESIGN OF REACTORS

Design of ideal batch, CSTR and Plug Flow Reactors and Residence Time Distribution.

UNIT- 4 KINETICS OF HETEROGENEOUS REACTIONS

Effect of transport processes on selectivity in series and parallel reactions, Rate equation for surface reactions, Determination of Surface area, porosity, density and particle size of catalyst

REFERENCE BOOKS:

1. Chemical Kinetics, S.K. Jain, Vishal Publication, Jallander.
2. Reaction Engg. Through Solved Problems. G.M. Pande & S.M. Shrivastava
3. Chemical Reaction Engineering Octave Levenspiel, Wiley Eastern ltd.
4. Chemical Engineering Kinetics, J.M. Smith, Mc. Graw Hill Co.
5. Fundamentals of Chemical Reaction Engineering, Holland & Anthony.
6. Chemical Reactor Theory, Lenbigh & Turner, University of Cambridge.

MSIC – 202

TECHNOLOGIES IN CHEMICAL INDUSTRIES

UNIT- 1 MEMBRANE TECHNOLOGY:

Classification of membranes and membrane processes, Basic operating principles and applications of various membrane processes – Micro filtration, Ultra filtration, Nano filtration, Reverse Osmosis, Dialysis, Membrane Distillation, Pervaporation, gas permeation, liquid membranes.

UNIT- 2 INTRODUCTIONS TO NANOTECHNOLOGY:

Introduction, Physical methods of synthesis of Nano materials: Mechanical & Vapor deposition, Chemical methods of synthesis of Nano materials: Colloids & Colliding solutions, Synthesis of Colloids, Synthesis of metal Nano particles, Properties and Applications.

UNIT- 3 INDUSTRIAL FORMULATIONS:

Study of Agrochemical Industries with respect to their Classification, Raw materials, manufacturing process of at least four products of each class with special emphasis on chemistry and manufacturing principles: Insecticides, Pesticides, Fungicides and Weedicides.

UNIT- 4 FERMENTATION TECHNOLOGIES:

Process calculations and Stoichiometry, Metabolic engineering, Transport in reactors, Design & Working of Bioreactor, Types of reactors, Sterilization, utilities: steam air water, Specific industrial process involving microbes. Industrial Production processes of…

REFERENCES:

1. Membrane Separation Processes by K. Nath; Prentice Hall India Ltd. (2008).
2. Principles of Fermentation Technology, P.F. Stanburry, A. Whitaker & S.J. Hall, Aditya Book Ltd.
3. Industrial Microbiology by AH Patel; Macmillan India Ltd
4. Membrane Technology in Chemical Industry, S.P. Nunes, K.V. Peinemann,
5. Membrane Processes: A Technology Guide; by Cardew PT & Le MS; Royal Soc. of Chem. (1998).
6. Principles of Biochemistryby, Lehninger AL; Nelson DL and Cox MM; CBS Publisher; 2nd Ed. (1993).
7. Biotechnology: The Biological Principles; by MD Trevan; S. Boffey; KH Goulding; and P Stanbury; Tata McGraw Hill Ed. (1988).
8. Biofuels: by Soetaert W. and Vandamme EP; 1st Ed. John Wiley & Sons Ltd. (2009).

MSIC – 203

HETEROCYCLIC CHEMISTRY

UNIT- 1 FIVE MEMBERED HETROCYCLES

Nomenclature, Synthesis, Reactivity and Reactions of:

5 membered Hetrocycles containing

- TWO heteroatoms (Pyrazole, Imidazole, Thiazole, Isothiazole, Oxazole, Isooxazole).
- More than two hetero atoms (1,2,4-Triozole, 1,3,4- Oxadiazoles, 1,3,4-Thiadiazoles)

UNIT- 2 SIX MEMBERED HETROCYCLES

Nomenclature, Synthesis, Reactivity and Reactions of:

6 membered Hetrocycles containing Nitrogen (Pyridine, Pyridazine, Pyrimidine, Pyrazine)

UNIT- 3 BENZOFUSED 5 & 6 MEMBER HETEROCYCLES

Nomenclature, Synthesis, Reactivity and Reactions of:

- Benzofused 5 membered Heterocycles with ONE hetero atom (Benzo(b)pyrrole, Benzo(b)Furan, Benzo(b)thiophene)
- Benzo fused 6 member hetero cycles (Quinoline, Isoquinoline, Cinnoline, Quinazoline, Quinoxaline, Phthalazine)

UNIT- 4 DISCONNECTION OF AROMEATIC HETEROCYCLES

Disconnection approaches for Aromatic 5 & 6 membered Heterocyclic compounds.

REFERENCE BOOKS:

1. The essence of Heterocycles, Dr A.R. Parikh et al.
2. Heterocyclic Chemistry 3rd Edition, J.A. Joule, K. Mills, G.F. Smith, Chapman & Hall
3. Principles of Modern Heterocyclic Chemistry. L.A. Paquette, Benjamin & Cummings
4. The Structure & Reactions of Heterocyclic Compounds, M.H. Palmer, Arnold
5. Heterocyclic Chemistry, A. Albert, The Athlone Press.
6. Organic Synthesis – The disconnection approach by Stuart Warren, Willey

MSIC – 204

INDUSTRIAL SAFETY AND MANAGEMENT

UNIT-1 PROCESS SAFETY:

Intrinsic & Extrinsic Safety. The hazards-Toxicity, Flammability, Fire, Explosions. Sources of Ignition, Pressure. Hazard and Risk assessment methods. MSDS

UNIT- 2 SAFETY DEVICES & PROCESS SAFETY ANALYSIS:

Pressure Relief Valve, Rupture Disks, Blow down Systems, Flare Systems, Flame arresters, Deflagration arresters and Explosion suppression, Personal Safety Devices.

Process Safety Analysis**:** HAZAN and HAZOP comparison, Risk analysis and Estimation, Safety check list, Computer based quantitative risk analysis.

UNIT- 3 GLP & GMP IN PHARMACEUTICAL INDUSTRIES:

GMP: Introduction, Various Schedule (X, O, M), Guidelines, Violation of GMP.

GLP: Introduction, Principles, Resources, Guideline, Violation.

UNIT- 4 SHUTDOWN & DISASTER MANAGEMENT:

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.

Disaster Management: Introduction, Classification, Disaster preparation, Prevention, Management, Natural disaster mitigation.

REFERENCE BOOKS:

1. Chemical Technology Vol. 1 by D. Venkateshwami. S.Chand and Co., New Delhi.
2. Energy Technology-Conventional & Non Conventional Systems, S. Rao, Khanna Pub.
3. Loss Prevention in chemical process industries, Vol. 1,2,3, Frank P. Less, Butterworth-Heiremann, 1980.
4. Chemical Engineers Handbook, Perry, 8th Ed. 2007.
5. Good Manufacturing Practices, Willing & Stokers, Marcel Dekker Inc.
6. Safety Managers Handbook, J.J. Keller & Associates, American Management Association.
7. Pilot Plant Models and Scale up Methods in Chemical Engineering by R.E. Johnstone and M.G. Thring, McGraw Hill Book Co.
8. Safe Handling of Chemicals in Industry Vol.1 & 2 by Carson and Mumford.

MSICP – 205

LABORATORY COURSE (SEM. - II)

Paper No.	Title	Experiments Based on following*
MSIC – 201	Chemical Reaction Engineering	• Chemical Kinetics
MSIC – 202	Technologies in Chemical Industries	• Synthesis of Collides/Nanoparticles
MSIC – 203	Heterocyclic Chemistry	• Derivatization of Heterocyclic compounds • Physico Chemical analysis
MSIC – 204	Industrial Safety and Management	

* Details to be worked out by the Department.

LIST OF PRACTICALS:

CHEMICAL KINETICS

1. To determine the reaction velocity constant for the reaction between acetone and iodine.
2. To determine heat and entropy of vaporization of a given liquid by a kinetic approach
3. To determine the kinetic parameters of the reaction and the temperature coefficient of the reaction between $KBrO_3$ and KI.
4. To determine the kinetic parameters of the reaction and the temperature coefficient of the reaction between $K_2S_2O_8$ and KI.

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Weighing balance
2. Stoppered Bottles
3. Pipettes
4. Measuring Flask, Conical Flasks etc…
5. Burettes
6. Stopwatch
7. Water bath, Ice bath.

NANOPARTICLES

1. To Prepare and characterize the ZnO nanoparticle
2. To Prepare and characterize the CuO nanoparticle
3. To Prepare and characterize the Fe_2O_3 nanoparticle
4. To Prepare and characterize the NiO nanoparticle

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. Muffle furnace
2. Centrifuger
3. UV-Viz spectrophotometer

PHYSICO- CHEMICAL

1. To determine the amount of Paracetamol in a given tablet using Spectrophotometer.
2. To examine Lambert- Beer law in concentrated solutions using Spectrophotometer.
3. To scan the absorption spectrum of $KMnO_4$ and to determine the wave length of maximum absorption using Spectrophotometer.
4. To determine the concentration of an unknown solution of optically active compound using Polarimeter.
5. To determine the dissociation constant of saturated benzoic acid by pH metry.
6. To determine the concentration of sodium acetate by conductometry.
7. To determine the concentration and amount of acid in a mixture of HCl and CH_3COOH by pH metry.
8. To determine the specific and molecular rotation of cane sugar and intrinsic rotation using Polarimeter.
9. To determine the concentration of saturated benzoic acid by Conductometry.
10. To determine the normality and dissociation constant of the given saturated benzoic acid by Potentiometry.
11. To determine the concentration and amount of acid in a mixture of HCl and CH_3COOH by Potentiometry.
12. To determine the molar refraction and refractive index of a given NaCl salt using Refractometer.
13. To study the variation of refractive index with composition of given liquids and also to determine the composition of unknown mixture using Refractometer.

LIST OF EQUIPMENTS/INSTRUMENTS/ GLASSWARES:

1. pH Meter
2. Potentiometer
3. Conductivity meter
4. Spectrophotometer
5. Polarimeter
6. Refractometer,
7. Weighing Balance

DERIVATIZATION OF HETEROCYCLIC COMPOUNDS :

1. To synthesize 2-Formyl Pyrrole from Pyrrole (Vilsmeier-Haack)
2. To prepare 3-Formyl Indole from Indole (Vilsmeier-Haack)
3. To prepare N-Acetyl Indole from Indole.(Acetylation)
4. To prepare 3-Acetyl Indole from Indole. (Acetylation)
5. To prepare 2-acetyl Furan from Furan. (Acetylation)
6. To Prepare 2-formyl Thiophene from Thiophene (Formylation)
7. To prepare 2-nitro Thiophene from Thiophene (Nitration)

LIST OF EQUIPMENTS/INSTRUMENTS/GLASSWARES:

1. Hot air Oven
2. UV Chamber
3. Weighing balance
4. Desiccator
5. Distillation assembly etc…
6. RBF assembly etc...
7. Water bath, Oil bath, Sand bath.
8. Thermometer