Enclosure-I

Syllabi for 3rd & 4th semester courses for UG programmes

B.Sc. INDUSTRIAL CHEMISTRY
SEMESTER-III

16UICCC09	**CORE-5** **UNIT OPERATIONS**	**04 HRS/WK**	**04 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 (09 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 (10 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 (09 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 **(09 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 **(11 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. Gavhane K. A. (2009), “*Unit Operations-II (Heat and Mass Transfer operations)”*, 23rd edition, Nirali Prakashan
2. Treybal R. E. (1981*), “Mass Transfer Operations”*, 3rd edition, McGraw Hill
3. McCabe & Smith (2001), “*Unit Operations in Chemical Engineering”*, 6th edition, McGraw Hall

REFERENCE BOOKS:

1. Sinnott R. K. (2010), “*Chemical Engineering Design”*, 5th edition, Elsevier, ISBN : 9380501161, 978-9380501161
2. Badger & Banchero (1998*), “Introduction to Chemical Engineering”*, 6th reprint, TMH
3. Foust et.el., (1994), “*Principles of Unit Operation”*, 2nd edition: John Wiley
4. 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

16UICCC10	**CORE-6** **DYES & DYEING,** **PIGMENTS & PAINTS**	**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 **(09 HRS)**

- Dyes – Introduction – Classification – Ancient and Modern theories based on Color and chemical constitution of dyes. Application of dyes in other areas – Leather, paper, medicine, chemical analysis, cosmetics, colouring agents Food and Beverages
- Optical Whiteners, Fluorescent brightener's and Fastness properties on various parameters.

UNIT-II: Dye's Intermediate **(10 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, Naphthol Sulphonic acid, Naphthyl amine sulfonic acids.
- Anthraquinone Intermediates: 1-Amino Anthraquinone, 2-Amino Anthraquinone, Bromamine acid, Quinazarin.

UNIT-III: Azo Dyes **(10 HRS)**

- Introduction - Classification - Various methods of Diazotizations.
- Sub-classes of Azo Dyes:- Mono azo, Bis azo, Tris azo and Poly azo dyes
- Mono azo Acid Dyes:- Acid Orange II, Acid Orange IV.
- Mono azo Mordant Dyes:- Eriochrome Black A, Eriochrome Black T, Eriochrome Black 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 **(09 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 **(10 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-III

16UICCC11	**CORE-7 MATERIAL SCIENCE**	**03 HRS/WK**	**03 CREDITS**

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 **(06 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 **(06 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 **(06 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 **(09 HRS)**

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

UNIT-V: Heat Treatments of Materials **(09 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. Narula G. 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. Wole Soboyejo, 2003, "*Mechanical Properties of Engineered Materials"*, Marcel Dekker, Inc, ISBN (0-8247-8900-8).

B. Sc. INDUSTRIAL CHEMISTRY
SEMESTER-III

16UICCC12	**CORE PRACTICAL-5 UNIT OPERATIONS PRACTICAL**	**04 HRS/WK**	**02 CREDITS**

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 perform steam distillation.
2. To study the distillation technique for given sample (Polar & Non-polar solvent)
3. To study the fractional distillation for given mixture of liquid(Polar & Non-polar solvent)
4. To determine the molecular condition of benzoic acid in kerosene and distilled water by the method of partition coefficient.
5. To determine practical yield for crystallization of Benzoic acid (By Cooling)
6. To determine practical yield for crystallization of Copper Sulphate (By evaporation)
7. To determine practical yield for crystallization of mixture of compounds(Benzoic acid + Copper Sulphate)
8. To determine practical yield for crystallization of Benzoic acid without seeding.
9. To determine practical yield for crystallization of Benzoic acid with seeding.
10. To study filtration rate of given sample.
11. To study the Construction and Working of Tray Drier.

B. Sc. INDUSTRIAL CHEMISTRY
SEMESTER-III

16UICCC13	**CORE PRACTICAL-6 DYES & DYEING, PIGMENTS & PAINTS PRACTICAL**	**06 HRS/WK**	**03 CREDITS**

OBJECTIVES:

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

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 Disperse dye
5. To prepare Methyl Red

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-IV

16UICCC14	CORE-8 UNIT PROCESSES	03 HRS/WK	03 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 (06 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 (08 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,
  - Phthalic anhydride,
  - 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 (08 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,
  - Chloro benzene,
  - 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 (08 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,
  - Dioctyl phthalate

UNIT-V: Amination and Ammoxidation (06 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. Groggins P. 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

16UICCC15	**CORE-9 ANALYTICAL CHEMICAL TECHNIQUE**	**03 HRS/WK**	**03 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 (08 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 (06 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 (06 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 (08 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 (08 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 (AUTONOMOUS)
SEMESTER-IV

16UICCC16	**CORE-10 MASS & ENERGY BALANCE**	**03 HRS./WK.**	**03 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 (06 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 (06 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 (06 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 (09 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 (09 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. Gavhane K.A. , (2012), "*Introduction to Process Calculations (Stoichiometry)*"**,** Volume-2: Nirali Prakashan, ISBN: 8190639668.
2. Oloman Colin, (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. Igbinoghene David 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

16UICCC17	CORE PRACTICAL-7 UNIT PROCESSES PRACTICAL	04 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 azo β-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.

16UICCC18	CORE PRACTICAL - 8 ANALYTICAL CHEMICAL TECHNIQUE PRACTICAL	06 HRS/WK	03 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 on basis of angle of rotation by using Polarimeter.