Academic Session: **2020-21**

FACULTY OF SCIENCES

SYLLABUS

FOR

M.Phil.
(Chemistry)

(Semester I-II)
Session: 2020-21

KHALSA COLLEGE
AMRITSAR

(An Autonomous College)

Note: (i) Copy rights are reserved.
Nobody is allowed to print it in any form.
Defaulters will be prosecuted.
(ii) Subject to change in the syllabi at any time.
Please visit the College website time to time for latest updates

Scheme of Courses

Eligibility:-The candidate having passed M.Sc. (Chemistry) or M. Sc. (Hons.) Chemistry or Equivalent degree with at least 55% marks from Guru Nanak Dev University or any other examination recognized equivalent there to by the University.

Semester-I

Courses common to all the three specializations (Organic, Inorganic and Physical Chemistry)

Subject Code	Subject	Max. Marks	Hrs
CHE-601	Research Methodology	100	60
CHE-602	Biocatalysis, Organocatalysis and Inorganic Catalysis	100	60
CHE-603	Advance analytical Techniques	100	60
	Total	**300**	**180**

Dissertation work will be assigned in the first semester.

Semester-II

Students of all the three specializations (Organic, Inorganic and Physical Chemistry) will take one Theory and One Practical course form the following along with Dissertation work presentation

Specialization Theory Course - One
Specialization Practical Course - One

Subject Code	Subject	Max. Marks	Hrs
	Inorganic Chemistry		
CHE-604	Inorganic Chemistry-II	100	60
CHE-605	Inorganic ChemistryPractical	100	60
	Organic Chemsitry		
CHE-606	Organic Chemistry - II	100	60
CHE-607	Organic ChemistryPractical	100	60
	Physical Chemistry		
CHE-608	Physical Chemistry-II	100	60
CHE-609	Physical ChemistryPractical	100	60
	Total	**200**	**120**

Semester-I

Academic Session: **2020-21**

M.Phil. ChemistrySemester-I

CHE 601: Research Methodology

60Hrs. **Time: 4 Hrs./Week**

Max. Marks: 75+25(Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1. Introduction to Research:

Objectives of research, motivation in research, types of research, significance of research, research methods vs methodology, research process in flow chart, criteria of good research, problems encountered by researchers in India.

UNIT-II

2. Use of Latex and Origin:

Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages.
Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, hypothesis testing, power and sample size, basic linear regression and curve fitting.

UNIT-III

3. Error Analysis and Basic Statistics:

Measuring errors, uncertainties, parent and sample distributions, mean and standard deviation of distribution, types of probability distribution, instrumental and statistical uncertainties, propagation of errors, specific error formulas, method of least square fitting.

UNIT-IV

Detection of some functional groups, Colour tests, Qualitative and Quantitativeaspects (a brief out line) as involved in steroids, Flavonoids, Vitamin A,Carbohydrates, Unsaturated skeletons & Amino acids etc.

References:

1) Research methodology (http://www.newagepublishers.com/samplechapter/000896.pdf)
2) The not so short introduction to LATEX by TobianOetiker, Hubert Partl, HreneHyna and Elisabeth Schlegl, Version 4.16, May 08, 2005
(http://tobi.oetiker.ch/lshort/lshort.pdf)
3) Origin Lab Manual (http://www.originlab.de/pdfs/GettingStarted.PDF)
4) Data reduction and error analysis for physical sciences by Philip R. Bevington and D. Keith Robinson
(http://www.physast.uga.edu/files/phys3330_fertig/BasicErrorAnalysis.pdf)

Academic Session: **2020-21**

M.Phil. ChemistrySemester-I

CHE 602: Biocatalysis, Organocatalysis and Inorganic Catalysis

60Hrs. **Time: 4 Hrs./Week**

Max. Marks: 75+25 (Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1Biocatalysis in Organic Chemistry:

Introduction to Biocatalysis. Application of Biocatalysts: Hydrolytic reactions, mechanistic and kinetic aspects, hydrolysis of amide bond, ester hydrolysis, hydrolysis and formation of phosphate esters, hydrolysis of epoxides, hydrolysis of nitriles. Reduction reactions: recycling of cofactors, reduction of aldehydes, ketones and carbon-carbon double bonds with whole cells. Oxidation reactions: oxidation of alcohols and aldehydes, epoxidation of alkene. Enzymes in organic solvents: ester synthesis, lactone synthesis, amide synthesis, peptide synthesis, redox reactions. (Books1,2,3)

UNIT-II

2. Organocatalysis in Organic Synthesis:

Introduction.Enamine catalysis: Aldol and Mannich type reactions, α-heteroatom functionalization, direct conjugate additions via enamine activation. Iminium catalysis: the catalysis concept, cycloaddition reactions, 1,4-addition reactions, transfer hydrogen, cascade reactions. Ammonium ions as chiral templates: Homogeneous catalysis with chiral quaternary ammonium salts, Heterogeneous catalysis- chiral phase transfer catalysis. Asymmetric proton catalysis: conjugate addition reactions, hydrocyanation reactions. Chiral Lewis bases as catalysts: allylation reactions, hydrocyanation and isonitrile addition, epoxide ring opening. Organocatalytic oxidation and reduction reactions.(4,5,6)

UNIT-III

3. Inorganic Catalysis (a):

Fundamental reaction steps of transition metal catalysed reaction. Coordinative unsaturation, oxidative-addition, elimination reactions, cleavage of C-H bonds, activation of sulphur hetrocycles, migration reaction, insertion reaction. (7)

UNIT-IV

4. Inorganic Catalysis (b):

Homogeneous catalysis by transition metal complexes. Hydrogenation reaction, alkene isomerization, hydrosilylation and hydroboration reaction, alkene hydrogenation, reaction of CO and hydrogen, hydroformylation of unsaturated compounds, carbonylation reactions, C-C cross coupling and related reaction, alkene oligomerization and polymerization, reaction of conjugated dienes, reaction of alkynes, valence isomerization of strained hydrocarbons, alkene and alkyne metathesis, oxidation, oxygen transfer reactions, supported homogeneous and phase transfer catalysis.(7)

References:

1. BiotransformationsIn Organic Chemistry: A Textbook by Kurt Faber 5th Edition Publisher: Springer-Verlag, New York, 2009.
2. Biocatalysis. Fundamentals and Applications by A. S. Bommarius (Georgia Institute of Technology) and B. R. Riebel (Emory University).Wiley-VCH, Weinheim, Germany. 2004.
3. The Organic Chemistry of Enzyme-Catalyzed Reactions by R. B. Silverman, Academic Press, New York, 2000.
4. Asymmetric Organocatalysis – From Biomimetic Concepts to Applications in Asymmetric Synthesis By A. Berkessel and H. Groger. Publisher: Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005.
5. EnantioselectiveOrganocatalysis: Reactions and Experimental Procedures Edited by Peter I. Dalko Publisher: Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007.
6. OrganocatalysisReetz, M.T.; List, B.; Jaroch, S.; Weinmann, H. (Eds.) Series: Ernst Schering Foundation Symposium Proceedings 2007-2, Publisher: Springer-Verlag, Berlin Heidelberg, 2008.
7. Advanced Inorganic Chemistry F.A Cotton 6th addition chapter 21 and 22, p. 1167-1294.

Academic Session: **2020-21**

M.Phil. ChemistrySemester-I
CHE 603: Advance Analytical Techniques

60Hrs. **Time: 4 Hrs./Week**
Max. Marks: 75+25 (Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1Magnetic resonance spectroscopy:

Nuclear magnetic resonance (NMR) in solid state, measurement of scalar couplings, measurement of dipolar couplings, measurement of "residual dipolar couplings".Recent techniques as applied to the structure elucidation of organic compounds NMR (Nuclear Magnetic Resonance; 1– D and 2– D), 1H and 13C-NMR

UNIT-II

2. X-ray Spectroscopy

Nature and Production X-rays, Origin of Spectra; Moseley's Law; Equipment for generation and detection of X-rays; Applications of X-ray emission and absorption methods for chemical analysis; X-ray fluorescence analysis; Diffraction studies; single crystal analysis; powder method of X-ray diffraction, structural applications of X-ray analysis

UNIT-III

3. Diffraction methods:

X-ray diffraction (XRD) of small molecules and macromolecules including natural systems; powder X-ray diffraction (XRD) of small molecules and macromolecules, measurement of lattice parameters, measurement of B-values, determination of space group, calculation of electron density map.

UNIT-IV

4.Electron microscopy:

Introduction, scanning electron microscopy (SEM), transmission electron microscopy (TEM), measurement of I/Q values, single particle 3-D reconstruction.

Fluorescence Spectroscopy; Introduction and its application

References:

1. E.M. Haacke, R.W. Brown, M.L. Thompson and R. Venkatesan, Magnetic Resonance Imaging: Physical Principles and Sequence Design, John Wiley, New York (1999).
2. M.J.Duer, Introduction to Solid-State NMR Spectroscopy, Blackwell Publishing (2004).
3. J.P. Glusker, M. Lewis and M. Rossi, Crystal Structure Analysis for Chemists and Biologists, VCH Publishers, New York (1994).
4. J.Kuo, Electron Spectroscopy:Methods and protocols, Humana Press (2007)
5. Sharma and S.G. Schulman, Introduction to Fluorescence Spectroscopy, Wiley Interscience (1999).
6. Spectroscopic Methods in Organic Chemistry 6th ed. by D. Williams and I. Fleming. Wiley-VCH, 1991
7. Spectrometric identification of Organic Compounds 6th ed. by R. M. Silverstein and F. X. Webster, Wiley, 2007.
8. Organic Spectroscopy and Chromatography by M Younas, ILMI, Pakistan, 2007.
9. Spectroscopy by Pavia, Lampman, Kriz, 2nd ed., Harcourt Brace College Publishers, 1996.
10. Electron spin resonance spectroscopy of organic radicals by FabianGerson, Walter Huber, Wiley-VCH Verlag GmbH &Co. KGaAWeinheim, 2003.
11. X-rays and electrons: an outline of recent X-ray theory By Arthur Holly Compton, Van Nostrandcompany.
12. Analytical Chemistry by J.D. Dick, McGraw Hill, 1973, N.Y. also available in International students edition McGraw Hill, Mogakusha, 1973.
13. Instrumental Methods by W. Ewing, McGraw Hill Book Co. N.Y. (Third/Fourth Edition) also available in international students edition.
14. New Instrumental Methods in ElectroChemistry by Faul-Delabay, Inter Science Publisher, London, N.Y.

Semester-II

Academic Session: **2020-21**

M.Phil. ChemistrySemester-II

CHE 604: Inorganic Chemistry

60Hrs. **Time: 4 Hrs./Week**

Max. Marks: 75+25 (Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1Heterogeneous Catalysis

Nature of heterogeneous catalysis, surface area andporosity, Surface acidic and basic sites in γ-alumina and characterization by IR,Surface metal sites, Catalytic steps: chemisorption and desorption, Surface migration,hydrogenation of alkenes, Synthesis of ammonia, oxidation of sulphur dioxide,Interconversion of aromatics by zeolites, Electrocatalysis, Application ofOrganometallic

UNIT-II

2. Compounds in Synthesis:

Metal alkyls; Grignard reagentsand alkyllithiums, Metal hydridesGroup theoretical approach to molecular orbital theory: Molecular orbital energylevels, heteronuclear molecules, triatomic molecules; carbon dioxide, nitrogendioxide, xenon difluoride; Walsh diagram, A group theoretical treatment in borontrifluoride (sigma and pi bonding), Diborane and bonding in hypervalentmolecules;phosphoruspentafluoride and sulphur hexafluoride

UNIT-III

3. Methods of formation of metal carbon bonds of main group elements (a):

Reaction between a metal and organic halogen compound, metal exchange reactions, reactionof organometallic compound with metal halides, insertion of olefins and acetylenes into metal-hydrogen bonds (hydrosilation; boron and aluminium), reaction of diazo compounds: aliphatic and aromatic diazo compounds, mercuration and thallation of aromatic compounds

UNIT-IV

4.Complexes of arenes:

Preparation of bis(arene) complex by Fischer's method, chemistry of bis (benzene) chromium, bis (benzene) molybdenum; arene(tricarbonyl)chromium complexes: nucleophilic attack on arene(tricarbonyl)chromium complexes, stabilization of α-carbonium ion, steric effect,

Chemistry of some arene complexes of iron, nucleophilic attack on organotransistion metal complexes, choice of organic ligands for nucleophilic attack (Greens rule), η6-cyclohetatriene and η7-tropylium complexes. Some Complexes of the lanthanides and actinides; organolanthanide and organoactinide chemistry with special emphasis on cyclopentadienylsandcyclooctatetraene complexes

Books Recommended:

1) Inorganic Chemistry, 3rd edition by D. F. Shriver and P.W. Atkins, *OxfordUniversity Press*

2) Concepts and Models of Inorganic Chemistry , 3rd edition by Bodie Douglas,Darl McDaniel and John Alexander,

3) Principles of Organometallic Chemistry by G.E. Coates, M.L.H. Green, P.Powell and K. Wade, *Chapman & Hall*

4) Principles of Organometallic Chemistry, 2nd edition by P. Powel, *Chapman &Hall*

Academic Session: **2020-21**

M.Phil. ChemistrySemester-II

CHE 605: Inorganic Chemistry Practical

60Hrs. **Time: 4 Hrs./Week**

Max. Marks: 75+15(Internal Assessment)

1. To prepare Grignard Reagent (Butyl Magnesium Chloride and Isopropyl magnesium chloride). Dry the solvents
2. Determine the concentration of prepared the Grignard reagent.
3. Preparation of hexaaminecobalt(III) sulphatepentahydrate, [Co(NH3)6]2(SO4)3.5H2O
4. Preparation of pentaaminesulphatocobalt(III) bromide, [Co(SO4)(NH3)5]Br
5. Preparation of bis(ethylenediamine)sulphato cobalt(III) bromide, [Co(SO4) (en)2]Br
6. Study the infrared spectrum of the sulphate group of the above compounds
7. Determination of available chlorine in bleaching powder
8. Determination of oxygen in hydrogen peroxide
9. Determination of copper, nickel, magnesium
10. Titration of mixtures using masking and demasking agents

Academic Session: **2020-21**

M.Phil. ChemistrySemester-II

CHE 606: Organic Chemistry

60Hrs. **Time: 4 Hrs./Week**

Max. Marks: 75+25 (Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1. The disconnection approach, meaning, basic principles involved in the Synthesisof Aromatic compounds. Disconnection and FGI, Synthons, Electroplphillicsubstitution, Nucleophillic aromatic substitution, Nucleophillic substitution ofhalides.

2. Three Membered Ring Formation: Introduction to Ring Synthesis, SaturatedHeterocycles, Cyclisation methods, Cyclopropane epoxide insertion reaction,Cyclopropyl Ketones Cyclopropanes.

UNIT-II

3. Four Membered Ring Formation: Photochemistry in Synthesis. Photochemical[2+2] Cycloadditions, Regioslectivity of photochemical [2+2] Cycloadditions.Formation of Four membered Ring by ionic Reactions use of Ketones inSynthesis: Introduction, mechanism, [2+2] Thermal cycloadditions. Ketenedimers.

4. Five Membered Ring Formation: From 1, 4-Dicorbonyl compounds, From 1, 5-Dicarbonyl compounds, Special methods for Five-membered Ring formation:Pericyclic Rearrangements in synthesis Electrocyclic Reaction. The dienone toCyclopentenone cyclisation.Sigma tropic Rearrangements.The vinylcyclopropane to cyclopentene rearrangement. [3, 3] Sigma tropic shifts: Thecalaisen, cope and carroll rearrangements.

UNIT-III

5. Rearrangements in Terpenoids:

Thermal Rearrangements: Introduction, Pyrolysis of Pinane, pinene, Sabinene,thujone, thujonenol, dipentene, germacrone and allred process. Alkylgroup migration in trpenes: Mechanism with suitable examples Abietic acid,pimaric acid dihydroabetic acid, α-amyrins and allied processes. Methylenemigration and related transformations.

6. Base induced Rearrangments: Introduction carbanion reactions, diesters,santonin, guaiolpatchoulene, oxido-Ketones. Cyclopropane ring formation, Noncarbanion reactions, mechanism with synthetic applications. Rearrangementsinvolving cyclobutane ring, mechanism and their synthetic applications.

UNIT-IV

7. Acid catalysed cyclisation's: cyclisation of Nerol, geraniol. α-onocerine,Zingiberene, citronellal, citral, geronic acid and allied transfromations.

8. Six Membered Ring Formation: Carbonyl Condensation: Robinson annelationDiels alder reaction, Reduction of aromatic compounds partial reduction Birchreduction.

9. Rearrangments in Synthesis: Diazo Ketones. Chain extension by diazomethane;the Arndt Eistert procedure.Diazoalkanes and Ketones.EpoxideRearrangements, arionic Rearrangements.The Farursku rearrangement.

Books Recommended:

1. Molecular Rearrangements. Part I & II. Paul De Mayo.

2. Principle of Organic Synthesis (3rd edition). ROC. Norman Kbefrs, J M

Coson.

3. Advanced Organic Chemistry (2nd Edition). F.A. Carey and J. Sundberg.

4. Design in Organic Syntghesis by S. Warron.

M.Phil. ChemistrySemester-II
CHE 607: Organic Chemistry Practical

60Hrs. **Time: 4 Hrs./Week**
Max. Marks: 75+15(Internal Assessment)

1. To synthesize cyclohexene through the dehydration of cyclohexanol.

2. To synthesize diphenyl-cyclopentadiene.

3. To synthesize 2-phenyl-indole.

4. To synthesize 1, 2, 3, 4 - tetrahydrocarbazole.

5. To synthesize Salicyldehyde.

6. To synthesize p-hydroxy-benzadehyde.

7. To synthesize 2-hydroxy-naphthaldehyde.

8. To synthesize o-nitro-resorcinol.

9. To synthesize Grignard reagents

10. To synthesize triphenyl-carbinol.

M.Phil. ChemistrySemester-II
CHE 608: Physical Chemistry

60Hrs. **Time: 4 Hrs./Week**
Max. Marks: 75+25 (Internal Assessment)

Instructions for paper setters and candidates

I. Examiner will make five sections of paper namely Section-I, II, III, IV and V
II. Examiner will set total of NINE questions comprising ONE compulsory question of short answer type covering whole syllabi and TWO questions from each unit.
III. Section-I will consist of TEN short questions carrying 1.5 Mark each.
IV. Section-II, III, IV and V of paper will consist of EIGHT questions in total having TWO questions from each unit of the syllabus and each question carry 15 Marks.
V. The students are required to attempt FIVE questions in all, taking ONE Compulsory question of section-I and one question from each section i.e. II, III, IV and V.

UNIT-I

1. Fast reactions:

Meaning, examples and historical background of fastreactions.Study of fast reactions by NMR technique. Principle andexperimental details of chemical relaxation technique like Temperature jumpand pressure jump technique. Relaxation time and derivation for the followingone step transformations:

i. Unimolecular reaction giving one product
ii. Bimolecular reaction giving one product.
iii. Bimolecular reaction (same reactant) giving one product.
iv. Bimolecular reaction (different reactants and two products).

Differences of fast reaction methods from conventional methods & uses offast reactions.

2. Principle and experimental details of ultrasonic method for the study of fast reactions like:

i. Ion association reactions
ii. Inter and Intermolecular proton transfer reactions
iii. Aggregation phenomena such as micelle formation

UNIT-II

3. Conducting Polymers:

Basic characteristics of CPs. Advantages ofCPs. Characterization of CPs such as: Polyacetylene, Polypyrrole,Polythiophene, Polyaniline, Poly(p-phenylene sulfide), Poly(p-phenylenevinylene). Structure and uses. Doping of CPs, Mechanism of conduction(Band theory).

UNIT-III

4. **Bio Polymers:**

Structural details of natural bioplymers such as protein, starch,cellulose, ATP.DNA.RNA.rubber, **Synthetic biopolymers:** Synthesis,structure and uses of polylactide, polycaprolactone and polyglycolide.

UNIT-IV

3. **Nanotechnology:** Nanoparticles and importance of nanotechnology tomankind. Preparation of nanoparticles, nanotubes, characterization ofnanoparticles by X-ray diffraction method(XRD), Transmission electronmicroscopy (TEM) &Thermogravimetric analysis (TGA).

Books Recommended:

1. Chemical Kinetic methods by C. Kalidas; New Age Int. Pub.

2. Polymers: Chemistry and Physics of modern material by J.M.G. Cowie;

Nelson Thornes Ltd.

3. Polymer Science by A.K.Ahluwalia and Anuradha Mishra; Ane books India.

4. Conducting polymers, fundamental and Application by PrassanaChandera-

Sekhar.

5. Hand book of conducting polymers by Terje A. Skotheim and John Reynolds.

6. Nanotechnology by Gregory Timp, AIP Press.

M.Phil. ChemistrySemester-II
CHE 609: Physical Chemistry Practical

60Hrs. **Time: 4 Hrs./Week**
Max. Marks: 75+15(Internal Assessment)

1. To determine the formula of complex formed between Cu2+ ion and ammonia using Nernst distribution law.
2. To determine the formula of complex formed between Ag+ ion and ammonia using Nernst distribution law.
3. To determine the CMC(critical micelle concentration) of sodium lauryl sulfate from conductivity measurements.
4. To determine the flocculation value of Fe(OH)3 sol using electrolytes KCI, K2SO4, K3[Fe(CN)6] and determine the validity of Hardy-Schulze rule.
5. To determine the transition temperature of Glauber's salt by solubility method.
6. To determine the solubility of given salt at room temperature and draw its solubility curve.
7. To determine hardness of water.
8. Estimation of Fat content in butter.
9. COD analysis of industrial samples.
10. Determination of free residual chlorine
11. Determination of Sponification value of oils and fats.