Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Syllabus

(2022-2023)

Under CBCS

Two Year Post Graduate Programme in Chemistry

(Four Semester Course)

Name of Department

Chemistry

Name of Course

Core Courses

M. Sc. First Year

Semester I & II

Syllabus Approved by the Board of Studies in Chemistry
With Effect from June, 2022

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
BoS in Chemistry

3. Introduction:

The Central Science, Chemistry is the link that connects problems in the fundamental nature of matter to the most complex problems in the processes of life. Taking this into consideration Rajarshi Shahu Mahavidyalaya, Latur conducts two year M. Sc. Degree programme in Chemistry (Organic Chemistry), which was established in June 2014 on non grant basis.

Organic chemistry finds its application to a large extent in the field of medicine, pesticides, petroleum sector, textile etc. It involves the design, chemical synthesis and development of pharmaceutical drugs. The duration of course is two years with 98 credits. The course is available in full time and the syllabus of the course is divided into 4 semesters. This course directly provides the opportunity to the students to seek his/her career in various pharmaceutical drug companies and also to the research and development branches of government oriented institutions.

The syllabus is prepared by keeping in mind the aim to make the students capable of studying Chemistry in academic and industrial courses. Also, to expose the students to Chemistry and to built up their interest in various fields of Chemistry. The new and updated syllabus is implemented from June 2022-23 based on disciplinary approach with vigor and depth .The syllabus is prepared after discussions of number of faculty members of the subject and by considering the syllabi of NET, SET, GATE examinations, UGC model curriculum, syllabi of different entrance examinations and syllabi of other Universities, in BoS meetings.

2. Title of the Programme: M. Sc. Chemistry

3. Learning Objectives of the Programme:

The programme aims to:

- Instill in students a sense of enthusiasm for learning Organic Chemistry which may lead to continuing professional development or pathways for lifelong learning.
- Produce postgraduates equipped with the skills to play an enhanced role in the Chemical Sciences nationally.
- Educate students in the theoretical (subject specific knowledge) and practical (laboratory based) aspects of the Organic Chemistry which relate to current and future employment needs.

- Provide students with the skills to adapt and respond positively to new developments in the workplace.
- Develop the critical, analytical, problem based learning skills required by the students in the workplace.
- Develop student's competences in a broad range of areas relevant to their current and future employment. Enhance and develop the student's interpersonal skills

4. Programme Specific outcomes/ Programme Outcomes:

The purpose of the two year M. Sc. chemistry programme is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry.

M.Sc. Chemistry outcome:

The two year postgraduate programme in M. Sc. Chemistry provides students with specialized knowledge and professional skills to prepare them for a career.
Upon successful completion of two year master programme in Chemistry, students should:
3. Students should have firm foundations in the fundamentals and application of current chemical and scientific theories.
2. Students should be able to integrate their knowledge from each of these areas with critical thinking skills in order to become problem solvers.
3. Students should have an advanced level understanding of at least three of the following areas of chemistry - Analytical, Inorganic, Organic, and Physical Chemistry
4. Students should broaden their professional foundations through activities such as teaching, internships, and fellowships
5. Students should be able to communicate scientific results in writing and in oral presentation.
6. Students should acquire the basic tools needed to carry out independent chemical research.
7. Students should become proficient in their specialized area of chemistry and successfully complete an advanced research project.
8. Students should find gainful employment in teaching or jobs in research and development, in public sector etc.

5. Advantages of Course:
This M. Sc. Chemistry programme allows students to develop a deeper understanding of the subject, whilst building advanced knowledge in aspects of Organic Chemistry; including organic reaction mechanisms, spectroscopy, Stereochemistry, and synthetic strategy.
This kind of high-level training is sought after by employers in the chemical industry as well as top academic institutions, working as fundamental research. In public sector students can find opportunities in Oil India, Geological Survey of India, Meteorological Survey of India and department of Oceanography.

6.	**Duration of the Course**	**:**	Two year
7.	**Eligibility of the Course**	:	B. Sc. with Chemistry
8.	**Strength of the Students**	:	As per the University/College rules
9.	**Fees for Course**	:	As per University/College rules
10.	**Admission / Selection procedure**	:	Admission by merit through Registration
13.	**Teacher's qualifications**	:	As per UGC/University/College rules
12.	**Standard of Passing**	:	As per UGC/University/College rules
13.	**Nature of question paper with scheme of marking**	:	As per UGC/University/College rules
14.	**List of book recommended**	:	Included in syllabus
15.	**Infrastructure details**	:	Website

Particulars	**Quantity**	**Particulars**	**Quantity**
Digital balance	05	Flame Photometer	01
Centrifuge machine	03	Refrigerator	01
Conductometer	12	Freezing point Apparatus	02
Colorimeter	15	Heating Mental	04
Distillation plant	01	pH-Meter	12
Electric Burner	08	Polarimeter	05
Digital Photofluorometer	02	Melting point Apparatus	02
Potentiometer	14	Rotary Shaker	01
Terbidometer	02	Abbes Refractometer	02
Ultrasonicator	01	FT-IR	01
Suction Machine	01	Magnetic Stirrer	12

Potentio-Galvanostat Electrostation	01	Universal Auto-titrator	01
UV-Visible Spectrophotometer	01	Rotamantle	04

16. **Rules and regulations and ordinance if any** : As per UGC/University/College rules

17. **Course duration** : Each theory course is of 60 Contact hours

18. **Medium of the language** : English

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
Syllabus
Faculty of Science
M.Sc. (First Year) Organic Chemistry
Semester - I
CORE COURSE CHEMISTRY

Code No.	Title of the course	Hours/Week	Marks (100)		Credits
			In. Sem.	End Sem.	
P-INC-142	Inorganic Chemistry-I	04	40	60	04
P-ORC-143	Organic Chemistry-II	04	40	60	04
P-PHC-144	Physical Chemistry-III	04	40	60	04
P-PMC-145	Physical Methods in Chemistry-IV	04	40	60	04
P-LAC-146	Lab Course -I (Inorganic Chemistry)	04	20	30	02
P-LAC-147	Lab Course -II (Organic Chemistry)	04	20	30	02
P-LAC-148	Lab Course -III (Physical Chemistry)	04	20	30	02
P-LAC-149	Lab Course -IV (Physical methods in Chemistry)	04	20	30	02
CCPCS-I	Seminar	01	--	25	01
Total			**625**		**25**

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M.Sc. (First Year) Organic Chemistry
Semester - II
CORE COURSE CHEMISTRY

Code No.	Title of the course	Hours/Week	Marks (100)		Credits
			Internal	External	
P-INC-241	Inorganic Chemistry-V	04	40	60	04
P-ORC-242	Organic Chemistry-VI	04	40	60	04
P-PHC-243	Physical Chemistry-VII	04	40	60	04
P-PMC-244	Physical methods in Chemistry-VIII	04	40	60	04
P-LAC-245	Lab Course V (Inorganic Chemistry)	04	20	30	02
P-LAC-246	Lab Course VI (Organic Chemistry)	04	20	30	02
P-LAC-247	Lab Course VII (Physical Chemistry)	04	20	30	02
P-LAC-248	Lab Course VIII (Physical methods in Chemistry)	04	20	30	02
P-LAC-249	Seminar	01	--	25	01
Total			**625**		**25**

CCPC- Core Course Post Graduation Chemistry
CCPCL- Core Course Post Graduation Chemistry Laboratory Course
CCPCS Core Course Post Graduation Chemistry Seminar

Theory Papers 100 Marks: (Internal 40*+External 60*)
*External S.E.E. 60 Marks Theory
* Internal 40 Marks (Two unit test - 30 + 30 = 60 marks+ Attendance 10Marks)
Unit Test I Activity Based 30 Marks
Unit Test II MCQ patterns 30 Marks
Unit test (I+ II) =60 Marks converted to 30 Marks

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Rajarshi Shahu Mahavidyalaya, (Autonomous) Latur - 413512

DEPARTMENT OF CHEMISTRY

Skeleton of Marks

Time: 3.30 hours (for Theory) Max. Marks = 30

A] Internal (Continuous Assessment) 40 (30+10*) Marks Each

- Unit Test -I (MCQ) 30 Marks
- Unit Test –II (Activity Based Test/Assignments) 30 Marks
- (Unit Test –I+II=60, Converted to 30)

B] Attendance 10* Marks

- Below 75 % 2.0
- 75.1 - 80.00 % 4.0
- 80.1 - 85.0 % 6.0
- 85.1 - 90.0 % 8.0
- 90.1 and above 10.0

C] Semester End Examination 60 Marks

Theory Course- 60 Marks

Practical Course- 30 Marks

(For Practicals 10 Marks are allotted to Practical Record Book and 10 Marks for Attendance)

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M.Sc. I (Chemistry) (Semester – I)
Paper – I
Inorganic Chemistry
Course Code: P-INC-142

Marks: 100 **Periods: 60**
Credit: 04 **04/Week**

Course Learning Objective:

1. To study inorganic reaction mechanisms, SN^1 reaction, SN^2 reaction, inner and outer sphere electron transfer reactions.
2. To understand the theories of Trans effect, Substitution reactions in square planar complexes.
3. To know Term symbols, microstates, Correlation diagram, Orgel diagram.
4. To study magnetic properties of complexes, Spin free and spin paired equilibria.

Course Learning Outcome:

After successful completion of the course the students:

1. Can understand inorganic reaction mechanisms, inner and outer sphere election transfer reactions.
2. Can apply trans effect rule in preparation of square planar complex
3. Calculate different term symbols, microstates of metal ions.
4. Gain the concepts of magnetic nature of different substance.

Unit – I Inorganic Reaction Mechanism – I **20 Periods**

1.1 Rate of reaction, factors affecting the rate of reactions
1.2 Definition of stability constant, stepwise and overall formation constant
1.3 Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand
1.4 Labile and inert complexes, VBT explanation of liability and inertness
1.5 Ligand substitution reactions, Acid hydrolysis, factors affecting the acid hydrolysis in octahedral complexes
1.6 SN^1 reaction – Introduction, characteristics, explanation with example using energy profile diagram and mechanism (Dissociative mechanism)
1.7 SN^2 reaction – Introduction, characteristics, explanation with example using energy profile diagram and mechanism (Associative mechanism)
1.8 SN^1CB reaction – Introduction, characteristics, explanation with example using mechanism
1.9 Anation reaction
1.10 Reaction without metal – ligand bond cleavage
1.11 Redox reactions (Electron Transfer Reactions) – Introduction, explanation with example, Inner and outer sphere election transfer reactions with mechanism, characteristics, essential requisites, factors which favor the outer and Inner sphere electron transfer reactions

Unit – II Inorganic Reaction Mechanism – II **10 Periods**

2.1 Substitution reactions in square planar complexes. Trans effect, Trans directing series

2.2 Theories of Trans effect – Polarization theory, Pi bonding theory, evidence in favour of trans effect theories, Defects of these theories

2.3 Application of trans effect in the synthesis of some square planar complexes with suitable example

Unit – III Spectral properties of metal complexes: **15 Periods**

3.1 Introduction

3.2 Spectrochemical and nephlauxetic series

3.3 Charge transfer – classification, mechanism and interpretation with suitable example, Luminescence spectra

3.4 Term symbol, Rules for determining the ground state term symbol for d^n configuration according to L-S coupling

3.5 Microstates – Calculation of number of microstates

3.6 Correlation diagram of d^1 and d^9, d^8 in octahedral and tetrahedral field

3.7 Orgel diagram of d1 to d9 configuration of an octahedral and tetrahedral environment

3.8 Tanabe – Sugano diagram of d^2 and d^3 configuration of an octahedral field

3.9 Racah parameter – calculation of D_q, β and B (Numericals)

Unit – IV Magnetic Properties of metal complexes: **15 Periods**

4.1 Origin of magnetism, Types of magnetism, Curie Law, Curie-Weiss Law

4.2 Magnetic properties of complexes – paramagnetism, 1^{st} and 2^{nd} ordered Zeeman effect, Quenching of orbital angular momentum by ligand field

4.3 Magnetic properties of A, E and T ground state terms in complexes

4.4 Spin free and spin paired equillibria

4.5 Spin cross over

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References:

1. Inorganic Chemistry – by shriver and Atkins (Oxford)
2. Concise Inorganic Chemistry – by J.D. Lee (Chapman & Hall)
3. Inorganic Chemistry : Principle, Structure and reactivity by Huheey, Keiter, Keiter Medhi (Pearson Education)
4. Inorganic – Chemistry by Catherine Housecraft.
5. Inorganic Chemistry by Messler and Tarr (pearson publishers)
6. Organ metallic Chemistry: A unified Approach by R.C. Mehrotra and A.Singh.
7. Principle of Bio inorganic Chemistry: by S.J. Lippard and J.M. Berg.
8. Bioinorganic Chemistry: Inorganic elements in Chemistry of life by – W.Kaim and B. Schwederski.
9. Bioinorganic Chemistry by Robert Hay.
10. Bioinorganic Chemistry by M.N. Hughes.
11. Bioinorganic Chemistry by R.J.P. wittams.
12. Bioinorganic Chemistry by Bertini, Gray, Lippard and Valentine.
13. Ligand field theory and its applications by B.N. Figg and M.A. Hitachiman (wiety VCH publication)
14. Symmetry and spectroscopy of mdecnles by K. Veera Reddy (New Age international Publication)
15. Elements of magneto Chemistry by R.L. Datta and syamal (Afiliated East – west press Pvt. Ltd.)
16. Advanced Inorganic Chemistry by F.A. cotton and Wilkinson (Johnwid)
17. Introduction to magneto Chemistry – Alan Earnshaw.
18. Same aspects of crystal field theory – T.M. Dunn. D.S. mecture and R.G. pearson.
19. Physical Chemistry through problems by Dogra and Dogra.
20. Chemistry of elements by B.N. Greenwood and A. Earnshaw.
21. The Determination of molecular structure by P.J. Wheatley.
22. Concise coordination Chemistry by R.Gopal, V.Ramlingam. (Vikas Publishing house Pvt. Ltd.)
23. Inorganic Chemistry by S.E. Huheey (Harper and Row)
24. Magneto Chemistry – By R.L. Carlin (Springer Verlag)
25. Addition of some reference books- Mc Danieal & Douglous
26. Magneto Chemistry BY Earnshaw

Paper –II
Organic Chemistry
Course Code: P-ORC-143

Marks: 100 **Periods: 60**
Credit: 04 **04/Week**

Course Learning Objective:

Objectives of the course are,

1. To clarify the concepts and principles of organic chemistry, types of mechanism, types of reactions, the Hammett equation etc.
2. To clear the concept of aromaticity of different non-benzenoid compounds, alternant and non alternant hydrocarbons, ferrocene, etc.
3. Enable students to outline mechanism of Aliphatic, Nucleophilic and Aromatic substitutions reactions.
4. To explain the Electrophilic and Nucleophilic addition reaction to carbon – carbon multiple bond and carbon–hetero atom multiple bond reactions.

Course Learning Outcome:

After successful completion of the course the students will:

1.Understand concept of organic chemistry, different reaction mechanisms
2. identify aromatic, anti-aromatic and non aromatic compounds well.
3. able to outline the mechanisms for Aliphatic, Nucleophilic and Aromatic substitutions reactions
4. able to outline the mechanisms for Electrophilic and Nucleophilic addition reactions

Unit – I Reaction Mechanism: Structure and Reactivity: 15 periods

1.1 Types of mechanism, types of reactions, Types of reagent, Thermodynamic and kinetic requirements, Kinetic and thermodynamic control, Hammond's postulate. Potential energy diagrams, Transition state and intermediates.

1.2 Effect of structure on reactivity-resonance and field effect, steric effect, Quantitative treatment. The Hammett equation and linear free energy relationship, Substituents and reaction constants.

1.3 Delocalised chemical bonding-conjugation, Cross-conjugation, Resonance, Hyperconjugation and Tautomerism.

1.4 Generation, Structure and stability of carbocation, carbanion, free radical, carbenes, nitrenes and arynes, strength of acids and bases.

Unit – II Aromaticity of Benzenoid and Non- Benzenoid Compounds: 15 periods

2.1 Introduction: Concept of aromaticity, Definition,

2.2 Theories of aromaticity: i) Molecular Orbital Theory, ii) Resonance Theory. Huckel's $(4n+2)\pi$ electron rule of aromaticity,

2.3 Aromaticity in benzenoids compound, alternant and non alternant hydrocarbons,

2.4 Aromaticity in non-benzenoid compounds, annulenes and hetero annulenes,

fullerenes C_{60}, tropane, tropoline, azulene, fulvene, tropylium salts, ferrocene.

2.5 2.5 Concept of anti-aromaticity.

Unit - III Substitution Reactions: 15 periods

3.1 **Nucleophilic Substitution:**

3.1.1.Aliphatic nucleophilic substitution:

a. The SN^2, SN^1, mixed SN^2 & SN^1 and SET mechanism, the neighbouring group participation by π & σ-bonds, Anchimeric assistance. The SN^1 mechanism.

b.Nucleophilic substitutions at an allylic, aliphatic and a vinylic carbon.

c. Reactivity; Effects of substrate structure, attacking nucleophile, leaving group and reaction medium.

3.1.2 Aromatic nucleophilic substitution:

3.1.3 SN^{Ar}, SN^1, Benzyne and SNR^1 mechanism. Reactivity: Effect of substrate, leaving group and attacking nucleophile.

3.2 **Electrophilic Substitution:**

3.2.1 Aliphatic Electrophilic Substitution.

3.2.2 Bimolecular mechanism –SE^2 and $SE^{3.}$ The SE^1 mechanism,

3.2.3 Electrophilic substitution accompanied by double bond shift.

3.2.4 Effect of substrate, leaving group and the solvent polarity on the reactivity.

3.2.5 Aromatic Electrophilic Substitution:

3.2.6 The arenium ion mechanism.

3.2.7 Orientation and reactivity.

3.2.8 Energy profile diagrams.

3.2.9 The ortho/para ratio. Ipso attack,

3.3.0 Diazonium coupling,

3.3.1 Vilsmeir reaction, Gattermann - Koch reaction.

Unit- IV Addition Reactions: 15 Periods

4.1 Addition to Carbon – Carbon Multiple Bond

4.1.1 Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals

4.1.2 Regioselectivity and chemoselectivity, orientation and reactivity.

4.1.3 Addition to cyclopropene ring

4.1.4 Hydroboration

4.2 Addition to Carbon –Hetero Multiple Bond

4.2.1 Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles.

4.2.2 Addition of Grignard's reagent.

4.2.3 Organo – zinc and organo-Lithium reagent to carbonyl and unsaturated carbonyl compounds.

4.2.4 Mechanism of Wittig Reaction and Mannich reaction.

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Reference Books:

Organic Chemistry

1 Advanced Organic Chemistry-Reaction Mechanism and structure, Jerry March, John Wiley.

2 Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.

3 A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4 Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.

5 Organic Chemistry, R. T. Morrison Boyd, Prentice-Hall.

6 Modern Organic Reactions, H. O. House , Benjamin.

7 Principles of organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional.

8 Reaction Mechanism in Organic Chemistry, S.M. Mukharji and S.P. Sing, Macmillan.

9 Organic Chemistry, Second Edition, Jonathan Clayden, Nick Greeves and Stuart Warren.

10 Organic Reaction Mechanism, Sanyal Taneja.

11 Organic Reaction Mechanism, V. K. Ahluwalia, Rakesh Kumar and Parashar.

Paper III
Physical Chemistry
Course Code: P-PHC-144

Marks: 100 **Periods: 60**
Credit: 04 **04/Week**

Course Learning Objective:

1. To understand the quantum Chemistry, Postulates of quantum mechanics, approximate methods.
2. To study concepts of laws of thermodynamics – G, H, A, S etc, concept of activity & activity coefficients.
3. To understand the concepts of Statistical Thermodynamics, Phase rule.
4. Ionic strength, Electrical double layer, Tafel equations etc.

Course Learning Outcome:

1. They can understand quantum Chemistry, Postulates of quantum mechanics, the variation theorem and Perturbation theory
2. They can know laws of thermodynamics, Partial molar properties Raoult's law
3. Students can understand Partition functions, recapitulation of phase rule and terms involved in it and concepts of Electrochemistry.

Unit - I Quantum Chemistry: **20 Periods**

1.1 Introduction – Failures of classical Mechanics, Origin of quantum mechanics.
1.2 The Postulates of quantum mechanics.
1.3 Schrodinger equation in Laplacian and Hamiltonian form. Discussion of solutions of the Schrodinger equation to (derivations).
1.4 a. Particle in one dimensional box
1.5 b. Particle in three dimensional box.
1.6 c. Harmonic Oscillator
1.7 d. Rigid rotator
1.8 e. Rigid rotator
1.9 f. Hydrogen like systems.
1.10 Orthogonality and Normalisation of wave functions.
1.11 Operators and related theorems – Algebra of Operators, Commutator, linear operators, Hamiltonian operators, hermitian operators, Ladder operators.
1.12 Approximate Methods –
   a. The variation theorem, Linear variation principle.
   b. Perturbation theory (first order and nondegenrate)
1.13 Numerical Problems on –
   a. Particle in 1D – box, 3D-box (degeneracy)

b. Orthogonality & Normalization
c. Operators.
d. Angular momentum-Eigen values and Eigen function

Unit II - Classical thermodynamics **15 Periods**

2.1 Brief resume of concepts of laws of thermodynamics – G, H, A, S etc
2.2 Partial molar properties – Partial Molar volume, partial molar heat content, partial molar free energy. (Chemical potential), significances & determination, Gibbs-Duhem equation.
2.3 Concept of fugacity – determination by graphical method and from equation of state, Duhem – Margules equation.
2.4 Concept of activity & activity coefficient:methods of determination.
2.5 Maxwell's thermodynamic relations.
2.6 Ideal and non ideal solutions (Raoults law), Excess functions for non-ideal solutions.

Unit III – Statistical Thermodynamics and Phase Rule **15 Periods**

3.1 Statistical Thermodynamics:

3.3.1 Introduction, Concept of distribution, thermodynamic probability, Ensemble and its types.
3.3.2 Partition functions – Translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions, applications of partition functions.
3.3.2 M-B, F-D and B-E statistics, Differences between them.

3.2 Phase Rule :

3.2.1 Recapitulation of phase rule and terms involved in it, Three component system: representation of ternary systems. Partially miscible three liquid systems:-
3.2.2 System composed of three liquid components, one partially miscible pairs, two partially miscible and three partially miscible pairs.
3.2.3 System composed of two solid and a liquid components:- formation of eutectic systems, crystallization of pure components only, formation of binary compounds, one double salt formation

Unit IV – Electrochemistry **10 Periods**

4.1 Ionic strength (problems)
4.2 Debye – Huckels limiting law (problems)
4.3 Electrical double layer – Theoreis of Helmholtz, Gouy – Chapman & stern.
4.4 Debye – Falkenhagen effect & wien effect.
4.5 Over potential & its types.
4.6 Exchage current density, derivation of Butler – Volmer equation, Tafel equations & Tafel plot.

References:

1. Physical Chemistry -P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry -A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry - Ira N. Levine, Prentice Hall.
4. Coulson's Valence -R. McWeeny ELBS.
5. Chemical Kinetics -K.J. Laidler, McGraw Hill.
6. Kinetics and Mechanism of Chemical Transformations -J. Rajaraman and J. Kuriacose, Macmillan.
7. Micelles, Theoretical and Applied Aspects - V. Moroi, Plenum
8. Modern ElectroChemistry Vol.I & II, J.O.M. Bockris & A.K.N. Reddy, Plenum
9. Introduction to Polymer Science - V.R. Gowarikar, N,V. Vishwanathan & J. Sridhar, Wiley Eastern.

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Paper – IV

Physical Methods in Chemistry

Course Code: P-PMC-145

Marks: 100 **Periods: 60**

Credit: 04 **04/Week**

Course Learning Objective:

1. To give the knowledge regarding the data handling and basic concepts in analytical Chemistry
2. To familiarize students with chromatographic separation techniques.
3. To give the students brief knowledge regarding forensic science.

Course Learning Outcome:

1. Students can analyse data statistically and understood the basic terms in analytical Chemistry
2. Students became familiar with principles and techniques of chromatography
3. Students received basic knowledge regarding forensic science.

Unit I – Basic Concepts of Analytical Chemistry and Chemometrics: 15 Periods

1.1 Basic Concepts of Analytical Chemistry

i. The nature of analytical Chemistry, the role of analytical Chemistry, qualitative and quantitative analytical methods,

ii. A typical quantitative analysis- sampling and treatment of samples, validation of a method.

1.2 Chemometrics

i. Concentration of solution based on volume & mass unit. Mole concept and concentration unit.

ii. Calculations of ppm , ppb , ppt and dilutions of solution, concept of mmol

iii. Stoichimometery of chemical reactions concept of kgmol, limiting and excess reactant, theoretical & practical yield.

iv Solubility & solubility equilibria, effect of presence of common ion.

v Calculation of pH of acids, bases & acidic – basic buffers

vi. Numaricals.

Unit II - Errors & Statistical treatment of Analytical Data **15 Periods**

2.1 Errors: Determinant, Constant and Indeterminate errors, Accuracy and Precision.

2.2 Distribution of random errors, Average deviation & standard deviation, variance and confidence limit, significant figures & computation rules, least square methods (Q, t, χ^2, F tests).

Unit III -Separation Techniques : **20 periods**

3.1 Solvent Extraction:

Introduction, theory, numerical problems, sequence of extraction process, extraction techniques: Batch extraction, stripping or back extraction, continuous extraction, counter current extraction and extraction of solids, Applications of solvent extraction, factors affecting solvent extraction of inorganic species, separation of metal ions as chelates.

3.2 Chromatography

Introduction, classification, basic principle and theory of chromatographic techniques.

i. **Thin Layer Chromatography**-Basic principle, experimental techniques, solvent system, plate development, detection of component, evaluation of chromatogram by different method, application of TLC.

ii. **Gas Chromatography-**Introduction, Techniques-Column efficiency, plate theory, rate theory, Advantages, Gas chromatogram, Instrumentation, Applications.

iii. **HPLC-**Introduction, principle, column efficiency in LC, mobile phase reservoirs, solvent treatment system, pumping system, sample introduction system, types of column, Detectors: EC and diode aray detectors, fluorimetic detectors, applications of HPLC.

Unit IV: - Forensic Analysis **10 Periods.**

4.1 Overview, Destructive and Nondestructive techniques, Data interpretation.

4.2 **Blood Analysis**: Blood preservation and ageing effects, Analysis of blood components and exogenic substances, blood stain analysis.

4.3 **DNA Profiling** : DNA and its polymorphism, DNA typing procedures-RFLP, PCR, MVR-PCR, Dot-blot, AMP-FLP, STR, other methods, paternity testing, applications.

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References:

1. Instrumental methods of chemical analysis (CBS) – H.H. Willard & L.L. Merritk, I.A. Dean.
2. Instrumental methods of Analysis – Chatval Anand.
3. Instrumental methods of chemical analysis – H. Kaur.
4. Fundamental Analytical Chemistry 8th edition – Skooq, west, holler, couch.
5. Analytical Chemistry 6th edition – L.D. Christain.
6. Computational Chemistry – A.C Noorris.
7. Computer for Chemistry – S.K. Pundir & Anshu Bansal.
8. Principal of Analytical Chemistry, Douglas & Koog, F.I. Holler & R.crouch 6th Edition, Thomson books / cole 2007.
9. H.P.L.C. Analytical Chemistry by open learning 2nd edition sundie lindsory Ed. John Willey & sons, New York 1993.
10. Instrumental Methods of Chemical Analysis – B.K. Sharma
11. Instrumental methods of Chemical Analysis – R.D. Braun.
12. Basic principles of spectroscopy – R Chang, Mc. Graw Hill.

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Practical
Inorganic Chemistry
Laboratory Course – I
Course Code: P-LAC-146

Marks: 50 **Periods: 60**
Credit: 02 **04/Week**

Course Learning Objective:

1. To learn about separation and estimation of binary and ternary mixture solutions. To understand about volumetric and gravimetric analysis of ions in binary and ternary mixture solutions.

Course Learning Outcome:

1. Students can know about separation and estimation of binary and ternary mixture solutions.
2. They can understand about volumetric and gravimetric analysis of ions in binary and ternary mixture solutions.

I) Separation and estimation of metal ions from the following binary mixture solutions:

one volumetrically and the other gravimetrically.(Any Four)

i) Copper – Nickel ii) Copper – Iron
iii) Nickel – Zinc iv) Iron – Magnesium
v) Copper – Barium vi) Iron – Aluminium

II) Separation and estimation of metal ions from the following ternary mixture solution by volumetrically and second gravimetrically. (Any Three)

i) Copper Nickel – Zinc ii) Copper – Nickel – Magnesium
iii) Iron – Nickel Zinc iv) Silver – Nickel – Magnesium
v) Silver–copper–Zinc

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Organic Chemistry
Laboratory Course –II
Course Code: P-LAC-147

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Course Learning Objective:

3. Studying experimental process of separation of the given organic binary mixture by physical method.
2. Understanding the organic synthesis by single stage preparation of organic compounds.
3. Studying experimental techniques such as simple distillation and thin layer chromatography for the purification and analysis of given organic compounds.

Course Learning Outcome:

After successful completion of the course the students will :
3. Able to separate the given organic binary mixture by physical method
2. Able to synthesize organic compounds by single stage preparation method.
3. Carry out various techniques for the purification and analysis of given organic compounds

I) Techniques

1 Simple Distillation
2 Thin layer Chromatography

II) Qualitative Analysis: Separation, purification, sample submission and identification of compounds of binary mixture (one solid and one liquid) by chemical method.
(any three)

III) Preparations (One Stage) Any Three

1. Preparation of Cinnamic acid by Perkin,s reaction.
2. Aromatic electrophilic substitution
   i. Synthesis of p-nitroaniline
   ii. Synthesis of p- bromoanaline
3. Aldol condensation – dibenzal acetone from benzaldehyde.
4. Sandmeyer Reaction – P- chlorotoulene from p- toludine.
5. Oxidation – adipic acid from cyclohexanol by chromic acid.
6. Cannizaro Reaction - 4-chlorobenzaldehyde as substrate.
7. Preparation of salicylic acid from phenol by Reimer-Tiemann reaction.,

[Note- 1) Preparation should be carried out using 0.02 to 0.05 mol of the starting material.

2) Yield, M.P. and TLC of purified product should be recorded.

3) Sample of purified product and TLC plate should be submitted for inspection.

Reference:

1) Vogel‟s practical Organic Chemistry

2) Comprehensive practical Organic Chemistry – A. K. Ahluwalia and Renu Agrawal

3) Hand book of Organic Analysis – Qualitative and Quantitative – H. Clark and Adwar

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Physical Chemistry
Laboratory Course III
Course Code: P-LAC-148

Marks: 50 **Periods: 60**
Credit: 02 **04/Week**

Course Learning Objective:

1 To determine the strength, concentrations, hydrolysis constant of solutions by conductometer
2 To determine pH, molar refractivity, freezing point by instrumental methods
3 To determine solubility, ionic strength, rate constant by non instrumental methods

Course Learning Outcome:

1 They can perform experiments using conductometer, PH-meter, refractometer
2 They can determine solubility, ionic strength, rate constant by non instrumental methods

NB

1 Performance of eight experiments is expected
2 At least one experiment on each instrument should be done.
3 Student should prepare the required solutions

SECTION-A: (INSTRUMENTAL)

CONDUCTOMETER:

1. To estimate the concentrations of sulphuric acid, acetic acid and copper sulphate in given solution.
2. To determine solubility product and thermodynamic properties (ΔG, ΔH, ΔS) of sparingly soluble salts.
3. To determine the relative strength of chloroacetic acid and acetic acid.
4. To determine the hydrolysis constant of Aniline hydrochloride.
5. To investigate basic hydrolysis of ethyl acetate at four different temperatures and to find out the energy of activation.

PH-METER:

1. To determine Hammet constant of given substituted benzoic acid.
2. To determine pH values of various mixtures of sodium acetate and acetic acid in aqueous solution and hence to find out dissociation constant of acid.

REFRACTOMETER:

1. To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and carbon tetra chloride and to calculate refractive equivalence of C, H and Cl atom.
3. To study the variation of refractive index with composition of mixture of CCl_4 and ethyl acetate.
4. Determination of molecular radius of molecule of organic compound.

FREZING POINT APPARATUS

1. Determination of molecular weight of compound by freezing point method.

SECTION B (NON-INSTRUMENTAL)

1. To determine partial molar volume of ethanol and water mixture at given composition.
2. To determine solubility of benzoic acid at different temperature and hence to determine it's heat of solution.
3. To determine effect of ionic strength on rate constant of reaction between potassium.
4. To investigate the autocatalytic reaction between $KMnO_4$ and oxalic acid and to find energy of activation.
5. To determine the rate constant of hydrolysis of methyl acetate catalysed by HCl per sulphate and potassium iodide.
6. To investigate the solubility of three component system and hence tie line on binodal curve.
7. To study the variation of viscosity with composition of mixture of
2. Ethanol-water, ii) methanol-ethylidene chloride
3. Nitric acid-Chloroform and determine whether or not there is compound formation between two liquids.

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Physical methods in Chemistry
Laboratory Course IV
Course Code:P-LAC-149

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Course Learning Objective:

To make students familiar with some electrochemical, optical, water analysis and kinetic study experiments.

Course Learning Outcome:

Students can carry analysis with some electrochemical, optical, water analysis and kinetic study experiments.

N.B. 3. Performance of eighteen experiments is expected
2. At least one experiment on each instrument should be done.
3. Student should prepare the required solutions

Section-A (Intrumental)

Conductometry :

1 Determination of the strength of strong acid and weak acid from mixture solution conductometrically
2 Analysis of aspirin by conductometric method.

Potentiometry :

1. Determination of the strength of halides in the given mixture using Potentiometry.
2. Determine the acid and basic dissociation constant of an amino acid (Glycine) and hence isoelectric point of an acid

Polarimetry :

1. Determination of rate constant for inversion of cane sugar by polarimetry.
2. Study of inversion of cane sugar by enzyme kinetics.
3. Determine the percentage of two optically active substances in a mixture polarimetrically.

Karl Fischer Titration:

1. Determination of number of water molecules in given compound by Karl Fischer Titration method

Section-B (Non-Instrumental)

Statistical analysis :

1. Application of 't' test for experimental data.
2. Application of rejection criteria ('Q' test) for experimental data.
3. Treatment of analytical data with least square method applied to Beer's law for $KMnO_4$ solutions.

Chemical Kinetics :

1. Investigate the reaction between bromic acid and hydroiodic acid.
2. To study the kinetics of iodination of acetone.

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Rajarshi Shahu Mahavidyalaya (Autonomous), Latur
M.Sc. I (Chemistry) (Semester – II)
Paper – V
Inorganic Chemistry
Course Code: P-INC-241

Marks : 100 **Periods: 60**
Credit : 04 **04/Week**

Course Learning Objective:

1. To understand the role of natural Metalloporphyrins.
2. To familiarize with inorganic Raman and ESR Spectroscopy.
3. To understand the chemistry of S and P block elements.
4. To understand Organometallics & Solid state Chemistry.

Course Learning Outcome:

1. They can know the role of natural metalloporphyrins like haemoglobin, myoglobin and chlorophyll.
2. Students get familiarize with inorganic Raman and ESR Spectroscopy and their difference.
3. Student should understand the detail chemistry of S and P block elements w.r.t. their compounds, their reactions and applications.
4. Students can understand the structure and bonding in Organometallics & concept of Solid state Chemistry

Unit – I Bio inorganic Chemistry: **15 periods**

1.1 Biological importance of essential and Non-essential elements..
1.2 Na / K Pump
1.3 Metalloporphyrins – structure of porphyrin molecule
1.4 Hemoglobin – structure, function of hemoglobin., Bhor effect
1.5 Myoglobin – structure and function, Difference between hemoglobin and myoglobin
1.6 Chlorophyll – structure and function, photosynthesis PS-I and PS-II
1.7 Cytochrome –structure, its types & functions
1.8 Electron carrier protein in biological system: Iron-suphur protein – Rubredoxin, ferrodoxin

Unit – II Inorganic Spectroscopy **15 Periods**

2.1 **IR Spectroscopy-**
Principle, Difference between IR and NMR Spectroscopy, IR spectra of some inorganic compounds

2.2 **Raman Spectroscopy.**
Principle, difference between IR and Raman spectroscopy, Raman spectra of inorganic compound

2.3 **ESR Spectroscopy.**
Comparison between ESR and NMR spectroscopy types of substances with unpaired electron, theory of transition metal ion as ESR indicator ion

2.4 **Mossbauer Spectroscopy**
Theory, Doppler Effect, Mossbauer spectra some inorganic compounds

Unit-III Chemistry of Main group elements **15 Periods**

3.1 Boron Group: Boron Hydrides, classification of boranes, preparation, structure and Bonding with reference to LUMO, HOMO, interconversion of lower and higher boranes, Metalloboranes, Carboranes

3.2 Carbon Group: C60 and its compounds (fullerenes), Intercalation compounds of Graphite, Graphene, Silicates

3.3 Nitrogen Group: Nitrogen activation, Oxidation states of nitrogen, phosphorus compounds

3.4 Oxygen Group: Oxyacids, and oxoanions of sulphur & nitrogen, comparison of strength of oxyacids

3.5 Halogen Group: Interhalogens, pseudohalogen, Synthesis, Structure, Properties and Application, Bonding

Unit–IV Organometallics & Solid state Chemistry: **15 periods**

4.1 Organometallics:

4.1.1 Introduction – stable electronic configuration, 18 – electron compound, electron count preference, electron counting by oxidation states and neutral method

4.1.2 Structure and bonding of lignads – carbon monoxide, cyclopentadience cycloheptarience and carbine

4.2 Solid state Chemistry

4.2.1 Electronic structure of solids and band theory, Limiting radius ratio, coordination number and their relationship

4.2.2 Stoichiometric defects – Introduction, schottky defect, frenkel defects

4.2.3 Non – stoichiometric defects – metal excess defect, F-centre Interstitial ions and electrons, metal deficiency defect. Positive absent, extra interstitial negative ions

4.2.4 Semiconductors – Introduction, N and P types of semiconductors

References:

1. Inorganic Chemistry – by Shriver and Atkins (Ox ford)
2. Concise Inorganic Chemistry – by J.D. Lee (Chapman & Hall)
3. Inorganic Chemistry : Principle, Structure and reactivity by Huheey, Keiter, Keiter Medhi (Pearson Education)
4. Inorganic – Chemistry by Catherine Housecraft.
5. Inorganic Chemistry by messler and tarr (pearson publishers)
6. Organ metallic Chemistry: A unified Approach by R.C. Mehrotra and A.Singh.
7. Principle of Bio inorganic Chemistry: by S.J. Lippard and J.M. Berg.
8. Bioinorganic Chemistry : Inorganic elements in Chemistry of life by – W.Kaim and B. Schwederski.
9. Bioinorganic Chemistry by Robert Hay.
10. Bioinorganic Chemistry by M.N. Hughes.
11. Bioinorganic Chemistry by R.J.P. wittams.
12. Bioinorganic Chemistry by Bertini, Gray, Lippard and Valentine.
13. Ligand field theory and its applications by B.N. Figg and M.A. Hitachiman (wiety VCH publication)
14. Symmetry and spectroscopy of mdecnles by K. Veera Reddy (New Age international Publication)
15. Advanced Inorganic Chemistry by F.A. cotton and Wilkinson (Johnwid)
16. Same aspects of crystal field theory – T.M. Dunn. D.S. Mecture and R.G. Pearson.
17. Concise coordination Chemistry by R.Gopal, V.Ramlingam. (Vikas Publishing House Pvt. Ltd.)
18. Inorganic Chemistry by S.E. Huheey (Harper and Row)
19. Instrumental methods of chemical analysis- Gurudeep R. Chatwal, Sham K. Anand
20. Instrumental methods of chemical analysis-H. Kaur

Paper –VI
Organic Chemistry
Course Code: P-ORC-242

Marks: 100 **Periods: 60**
Credit: 04 **04/Week**

Course Learning Objective:

1. To introduce the types of free radical reactions.
2. To confront students with E^2, E^1 and E^1CB mechanisms.
3. To clarify the concept of pericyclic reactions and their types.
4. To give perceptions about the photochemistry and their terms.

Course Learning Outcome:

After successful completion of the course the students will:

1. Became familiar with different types of free radical reactions and their applications.
2. able to outline the mechanism of different E^2, E^1 and E^1CB reactions and understand their applications.
3. know the concepts of electrocyclic reactions, cycloaddition reactions, Sigmatropic rearrangements etc.
4. Became familiar with photochemical theory, photoreduction reactions, Photo –fries reactions etc.

Unit – I Free radical reactions: **15 Periods**

1.1 Introduction
1.2 Types of free radicals:
  1.2.1 Stable free radicals
  1.2.2 Short lived free radicals
1.3 Stability of free radicals.
1.4 Configuration of free radicals.
1.5 Mechanism of free radical reactions and applications of free radical reactions

Unit - II Elimination Reaction: **10 Periods**

2.1 The E^2, E^1 and E^1 CB mechanisms and their spectrum.
2.2 Orientation of the double bond.
2.3 Reactivity: Effects of substrate structures, attacking base, the leaving group and the medium.
2.4 Mechanism and orientation in pyrolytic elimination.

Unit - III: Pericyclic Reactions: **18 Periods**

3.1 Molecular orbital symmetry.

3.2 Frontier orbitals of ethylene, 1,3-butadiene,1,3,5-haxatriene and allyl system.

3.3 Classification of pericyclic reactions.

3.4 Woodward Hoffmann correlation diagrams.FMO and PMO approach.

3.5 **Electrocyclic Reactions:**

3.5.1 Conrotatory & disrotatory motions in ring opening and ring closing reactions.

3.5.2 Ring opening and ring closing reactions in which polyenes having 4n , 4n+2 Ꝑ electron systems.

3.6 **Cycloaddition Reactions:**

3.6.1 [2+2] Cycloaddition reactions.

3.6.2 [4+2] Cycloaddition reactions,

3.6.3 1,3-dipolar cycloadditions

3.6.4 Cheleotropic reactions.

3.7 **Sigmatropic rearrangements:**

3.7.1 Suprafacial and antarafacial shifts of H.

3.7.2 Sigmatropic shifts involving carbon moieties, 3,3 and 5,5-Sigmatropic rearrangements.

3.7.3 Claisen, Cope and Aza–Cope rearrangement.

Unit IV Photochemistry: **17 Periods**

4.1 Principles – Photochemical theory.

4.2 Electronic excitation, singlet and triplet states,

4.3 Jablonski diagram, Energy transfer and quantum efficiency.

4.4 Photochemistry of carbonyl compound:

4.4.1 Photoreduction

4.4.2 Norrish type – I & II

4.4.3 Paterno- Buchi reaction.

4.5 Photochemistry of alpha, beta-unsaturated ketones.

4.6 Photochemistry of olefins: cis – trans isomerism.

4.7 Photo–Fries reaction of anilides, Barton reaction and nπ-pπ rearrangements.

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Reference Books:

1. Advanced Organic Chemistry-Reaction Mechanism and structure, Jerry March, John Wiley.

2 Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg , Plenum.

3 A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4 Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.

5 Organic Chemistry, R.T. Morrison Boyd, Prentice-Hall.

6 Modern Organic Reactions, H.O.House , Benjamin.

7 Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and professional.

8 Pericyclic Reactions, S.M. Mukharji, Macmillan, India.

9 Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh,Macmillan.

10 Photochemistry and Pericyclic Reactions, Jagdamba Singh and Jaya Singh.

Paper –VII

Physical Chemistry

Course Code: P-PHC-243

Marks :100 **Periods: 60**
Credit : 04 **04/Week**

Learning Objective:

1. To clarify the concept of Chemical Kinetics and reaction dynamics
2. To explain the concepts about surface tension, Gibbs adsorption isotherm etc.
3. To give the knowledge of micelles & macromolecules.
4. To familiarize students with thermodynamic and kinetic requirements of a reactions
5. Student will develop computational chemistry literacy and perform computational Chemistry task.

Course Outcome:

After successful completion of the course the students will:

1. Understand the concept of Chemical Kinetics and reaction dynamics like ionic reactions, steady state approximation etc.
2. Know about surface tension, Gibbs adsorption isotherm, BET adsorption isotherm.
3. Gain the knowledge of micelles, CMC, macromolecules and difference between polymers and macromolecules.
4. Became familiarize with thermodynamic and kinetic requirements of a reactions.
5. Students can operate different softwares in Chemistry and apply their knowledge of computational Chemistry for solutions of research problems.

Unit I: - Chemical Kinetics and reaction dynamics: 15 Periods.

1.1 Recapitulation – Zero, first, second, third, fourth, order rate equation, molecularity & order methods of determining order of reaction, fractional order reactions

1.2 Theories of reaction rates – collision theory, TST and Lindemann theory. (in detail).

1.3 Oscillatory reactions (B-Z reaction)

1.4 Ionic reactions – Kinetic Salt effects

1.5 Enzyme catalysis: - Michaelis – Menten mechanism, limiting rate, lineweaver-burk and Eadie plots

1.6 Numaricals Steady state approximation – Study of mechanism of reaction using chemical kinetics, problems

1.7 Kinetics of free radical and condensation polymerization

Unit II :- Surface Chemistry, Micelles & Macromolecules 15 Periods.

2.1 Surface Chemistry

2.1.1 Surface tension, capillary action, pressure difference across curved surfaces (Laplace equation).

2.1.2 Gibbs adsorption isotherm & BET adsorption isotherm, estimation of surface area from BET isotherm.

2.1.3 Kelvin equation for vapour pressure of droplets.

2.2 Micelles

2.2.1 Surface active agents, classification.

2.2.2 Micelles, process of Micellisation, CMC, factors affecting CMC, thermodynamics of micellisation, cleansing action of soap & detergent.

`2.3 Macromolecules

2.3.1 Definition, examples.

2.3.2 Difference between polymers and macromolecules.

2.3.3 Types of polymers – electrically conducting, fire resistant, liquid crystal & stereoregular polymers.

2.3.4 Molecular Mass (Determination of Molecular Mass by – Viscometry, Osmometry & Light Scattering Method)

2.3.5 Numaricals

Unit III:- Molecular Symmetry and Group Theory 15 Periods.

3.1 Symmetry criterion of optical activity, symmetry restrictions on dipole moment. A systematic procedure for symmetry classification of molecules

3.2 Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups.

3.3 Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations

3.4 The Great Orthogonality Theorem and its application in construction of character tables for point groups C_2v, C_3v and D_2h, structure of character tables.

3.5 Group-subgroup relationships.

3.6 Reduction of reducible representations using reduction formula.

3.7 Mulliken's notations for irreducible representations.

3.8 Determination Number of different modes of Vibrations.

3.9 Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in ABn (Ammonia, CH4) molecule.

Unit IV- Computational Chemistry: 15 Periods

4.1 Numerical Methods: Introduction ,Basic Programming Techniques, Interpolation and Curve Fitting, Roots of Equations, Matrix Methods, Differential Equations, Numerical Integration, Integral Transforms

4.2 Quantum mechanical calculations: Ab initio methods –I (Hartree Fock), Ab initio methods - II (Post Hartree Fock),

4.3 Density functional methods, Softwares for quantum mechanical calculations, Different forms of inputs for Ab initio calculations.

4.4 Computation of single point energies, Geometry optimization, Electron densities and electrostatic potentials

4.5 Analysis of output for Gausian programmes – I & Analysis of output for Gausian programmes – II

4.6 Molecular frequencies, Modeling in solutions – I Modeling in solutions – II

4.7 Thermodynamic functions, NMR frequencies, QSAR, Transition states.

Reference books:

1 Physical Chemistry -P.W. Atkins, ELBS.

2 Introduction to Quantum Chemistry -A.K.Chandra,Tata McGraw Hill.

3 Quantum Chemistry - Ira N.Levine, Prentice Hall.

4 Coulson's Valence -R. McWeeny ELBS.

5 Chemical Kinetics -K.J.Laidler, McGraw Hill.

6 Kinetics and Mechanism of Chemical Transformations -J.Rajaraman and J.Kuriacose Macmillan.

7 Micelles, Theoretical and Applied Aspects - V.Moroi, Plenum

8 Modern ElectroChemistry Vol.I & II, J.O.M. Bockris & A.K.N. Reddy, Plenum

9 Introduction to Polymer Science - V.R.Gowarikar, N,V.Vishwanathan & J. Sridhar, Wiley Eastern.

10 Advanced physical Chemistry – J.N. Gurtu & A. Gurtu, A Pragati.

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Paper– VIII
Physical Methods in Chemistry
Course Code:P-PMC-244

Marks : 100 **Periods: 60**
Credit : 04 **04/Week**

Course Learning Objective:

1. To familiarize students with electrochemical, spectroscopic and thermal analysis techniques.
2. To clarify the concepts about diffraction Methods.

Course Learning Outcome:

1. Student will become familiarize with principles of polarography & voltametry**,** atomic absorption spectroscopy, flame photometry etc.
2. They will understand thermogravimetric analysis, X-ray diffraction (XRD) methods

Unit I – Electroanalytical Techniques: **15 Periods**

1.1 **Polarography & Voltametry ;**

Principle of polarography, instrument polarographic measurement, DME, HDME, polarogram, Half wave potential, currents contributing to polarographic wase, departure of polarographic waves, conditions for performing polarographic determination. Applications of polarography, modified polarographic techniques, Voltametry, cyclic voltametry, stripping voltanetry, Hyrodynamic voltametry, numerical

1.2 **Electrogravimetry :**

Theory, Important terms used in electrogravimetric methods, overpotential electrogravimetric methods, insturementation electrolysis using mercury cathode, spontaneous or internal electrolysis, determination of metal by constant current procedure, determination of metal by controlled potential methods, electrography

Unit II - Spectroscopic techniques : **15 Periods**

2.1 **AAS (Atomic absorption Spectroscopy)**

Introduction, principle of AAS, absorption of radiant energy by atoms,

classification of atomic spectroscopic methods, measurement of atomic absorption, instrumentation, atomic absorption spectrophotometer, detection limit, interferences in AAS applications, some typical determination, difference between AAS & FES, advantages & disadvantages of AAS

2.2 **Flame photometry (Flame Enission Spectroscopy)**

Principle, flames & flame temperature, excitation profiles & chemical reaction in flames, spectra of metal in flame, instrumentation, evaluation methods in flame photometry, factors affecting intensity of emitted radiation, interferences in flame photometry, background correction methods, applications, flame emission experiments, limitations numerical, applications

Unit III - Thermal Methods : 15 Periods

3.1 Thermogravimetric analysis (TGA) :- Introduction , Thermoanalytical methods, Thermogravimetric analysis, instrumentation, modern thermobalances, interfacing TGA to FTIR or MS for EGA, DTGA, factors affecting TGA, simultaneous TG-DTA-MS analysis, Applications of TGA.

3.2 Differential thermal analysis (DTA) Introduction, theory, differential scanning calorimetry, instrumentation for DTA, heat flux DSC, simultaneous DTA & TGA curves, factors affecting DTA and DSC, Applications.

Unit IV – Diffraction Methods : 15 Periods

4.1 **X-ray diffraction (XRD):**

Bragg condition, Millers indices, Laue method, Powder XRD Bragg method, Debye – scherrer method of X-ray structural analysis of crystals, index reflections, indentification of unit cells from systematic absences in diffraction pattern, structure of simple lattices and X-ray intensities, structure factor and its relation to intensity of electron density, phase problem. Numericals on Bragg equation.

4.2 **X-ray florescence spectroscopy:**

Principle, Instrumentation and Applications.

Reference:

1. Instrumental methods of chemical analysis (CBS) – H.H. Willard & L.L. Merritk, I.A. Dean.
2. Instrumental methods of Analysis – Chatval Anand.
3. Instrumental methods of chemical analysis – H. Kaur.
4. Fundamental Analytical Chemistry 8th edition – Skooq, west, holler, couch.
5. Analytical Chemistry 6th edition – L.D. Christain.
6. Computational Chemistry – A.C Noorris.
7. Computer for Chemistry – S.K. Pundir & Anshu Bansal.
8. Principal of Analytical Chemistry, Douglas & Koog, F.I. Holler & R.crouch 6th Edition, Thomson books / cole 2007.
9. H.P.L.C. Analytical Chemistry by open learning 2nd edition sundie lindsory Ed. John Willey & sons, New York 1993.
10. Instrumental Methods of Chemical Analysis – B.K. Sharma
11. Instrumental methods of Chemical Analysis – R.D. Braun

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Practical
Inorganic Chemistry
Laboratory Course-V
P-LAC-245
Course Code: CCPC-L-V

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Course Learning Objective:
To perform semi micro qualitative inorganic analysis of three acidic and three basic radicals and synthesis of inorganic complexes.

Course Learning Outcome:
They can identify different acidic and basic radicals by qualitative analysis and prepare different inorganic complexes.

I) Semi micro qualitative inorganic analysis (At least 08 mixtures)

Three acidic and three basic radicals including one rare earth metal ions like – Mo, W, Tl, Se, Te, Ti, Zr, Ce, Th U V, Be, Li, and acidic radicals like –

II) Synthesis of complex

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Organic Chemistry
Laboratory Course –VI
Course Code: P-LAC-246

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Course Learning Objective:
To carry out Steam distillation, column chromatography and double stage synthesis.
Course Learning Outcome:
Students can do Steam distillation, column chromatography and perform double stage synthetic methods.

1. Demonstration:
a) Steam distillation
b) Column chromatography
1 **2. Qualitative analysis**: Separation, Purification, Sample submission and Identification of compounds of binary mixture (Solids) by physical (Ether extraction) method (Any four)

3. Preparations (**double stage**) (**any three**)
a) Phthalic acid ------ phthalic unhydride------- anthranilic acid
b) Acetophenone------ oxime------ acetanilide
c) Chlorobenzene-----2,4 –dinitro chlobenzene-----2,4-dinitroaniline
d) Acetanilide-------- p-bromoacetanilide---- p-bromoaniline
e) Benzoin----- benzyl----- benzilic acid

Note: 1) Preparation should be carried out using 0.02 to 0.05 mol of the starting material.
2) Yield, m.p. and TLC of purified product should be recorded .
3) Sample of purified product and TLC plate should be submitted for inspection.

Reference :
1) Vogel,s practical Organic Chemistry
2) Comprehensive practical Organic Chemistry – A. K. Ahluwalia and Renu Agrawal
3) Hand book of Organic Analysis – Qualitative and Quantitative – H. Clark and Adward Arnold.

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Physical Chemistry
Laboratory Course VII
Course Code:P-LAC-247

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Course Learning Objective:

1. To determine equilibrium quotient, concentration of in by colorimeter.
2. To determine pK_1 pK_2 values, oxidation state of metal ion by potentiometer.
3. To find out molecular weight, surface tension, order of reaction.

Course Learning Outcome:

1. They can determine equilibrium quotient, concentration of in by colorimeter.
2. Students can determine PK_1 PK_2 values, oxidation state of metal ion by potentiometer.
3. They can find out molecular weight, surface tension, order of reaction, by non instrumental methods.

N.B.

1. Performance of eight experiments is expected
2. At least one experiment on each instrument should be done.
3. Student should prepare the required solutions

Section-A: (Instrumental)

Conductometer:

1. To determine critical micelle concentration of sodium lauryl sulphate in aqueous solution.

Colorimeter :

1. To determine equilibrium quotient for formation of mono thiocyanate iron (III) complex.
2. To determine Indicator constant of an indicator.
3. To determine concentration of Cu (II) iron in given solution titrating with EDTA solution.

Potentiometer :

1. To determine PK_1 PK_2 values of Phosphoric acid.
2. To determine strength of strong acid and weak acid in given mixture.
3. To determine the oxidation state of metal ion by method of concentration
4. cell without transference

Polarimeter :

1. To determine the relative strength of two acids.

2. To determine the percentage of two optically active substance (d-glucose and d-tartaric acid) in the mixture.

Section B (Non-instrumental)

1. To determine molecular weight of high polymer by viscosity measurement.
2. To study the effect of surfactant on surface tension of water by using Stalagmometer
3. To determine surface tension of methyl acetate, ethyl acetate and chloroform and hence to calculate atomic parachors of C, H, Cl.
4. To determine order of reaction of given reaction kinetics by fractional change method.
5. To study distribution of benzoic acid between benzene and water at room temperature and hence show that benzoic acid dimerises in benzene.
6. To study distribution of benzoic acid between benzene and water at room temperature and hence show that benzoic acid dimerises in benzene.

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Analytical Chemistry
Physical methods in Chemistry
Laboratory Course VIII
Course Code: P-LAC-248

Marks : 50 **Periods: 60**
Credit : 02 **04/Week**

Note:

1. Performance of eight experiments is expected
2. At least one experiment on each instrument should be done.
3. Student should prepare the required solutions

Course Learning Objective:

1. To train students in handling of electroanalytical and spectroscopic techniques.
2. To train students in handling of chromatographic techniques
3. To train them to analyse the chemical constituents with heterogeneous equillibria.

Course Learning Outcome:

1. Students will be able to handle electroanalytical and spectroscopic techniques.
2. Students will be able to separate mixture components by chromatographic techniques
3. Students will be able to analyse the chemical constituents with heterogeneous equillibria are available.

Section-A (Intrumental)

pH-metry:

1. Acid-base titration in non-aqueous media by pH-metry (benzoic acid in ethanol / NaOH).
2. Determination pKa of weak acid by pH-metry.
3. Determination of degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Colorimetry:

1. Verification of Beer's law for a) $KMnO_4$ and Cu^{2+} ammonia complex solution.
2. Determination of empirical formula for the formation of ferric salicylate complex by Job's method.
3. Determination of stability constant for the formation of complex between Fe^{3+} ions and 5-sulphosalicylic acid.

Flame photometry:

1. Estimation of Na^+ / K^+ by Flame photometry

Fluorimetry:

1. Determination of analyte in given sample by fluorimetry

Section-B (Non-Instrumental)

Chromatography:

1. Separation of cations and anions by paper chromatography and determination of RF values.
2. Determination of Ion-exchange capacity of a cation exchanger.
3. Determination of Ion-exchange capacity of an anion exchanger.

Heterogeneous equilibria:

1. Determine the formula of complex form between cupric ion and ammonia by distribution method.
2. Investigate the solubility of three component system and hence draw a tie lone on bimodal curve.

Water Analysis:

1. Determination of hardness of water by complexometric titration.

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