Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Two Year Post Graduation Degree

Undergraduate Programme of Science and Technology

M.Sc. Chemistry

Board of Studies

In

Chemistry

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

w.e.f. June, 2023

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. (Research /Degree) in Chemistry** Programme to be effective from the **Academic Year 2023-24.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 09/08/2023

Place: Latur

NEP Cell

Rajarshi Shahu Mahavidyalaya, Latur

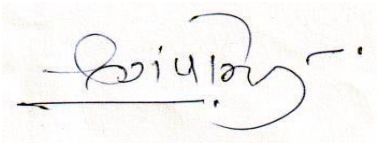
(Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc Chemistry** Programme to be effective from the **Academic Year 2023-24.**

Date:

Place: Latur



Prof. Dhananjay Palke

Chairperson
Board of Studies in Chemistry
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Members of Board of Studies in the Subject Chemistry
Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	**Prof. Dhananjay Palke** Head, Department of Chemistry, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Chairperson	HoD
2	**Prof. Vijay Bhosale** Department of Chemistry, Yeshwant Mahavidyalaya, Nanded. Mo.No.9403067252	Member	V.C. Nominee
3	**Prof. S. P. Hangiragekar Department of** Chemistry, Shivaji University, Kolhapur Mo.No.9890363931	Member	Academic Council Nominee
4	**Dr. Bapu B. Shingate** Department of Chemistry, Dr. B. A. M. U. Aurangabad Mo.No.9850298591	Member	Academic Council Nominee
5	**Prof. S. B. Patwari** Chemistry, Laal Bhadur Shastri, Mahavidyalaya, Dharmabad Mo.No.9067583746	Member	Expert from outside for Special Course
6	**Dr. Pinak M. Chincholkar** Springer Nature Technology & Publishing Solutions. Tower 8 and 9 Magarpatta City, Hadapsar. Pune. Mo.No.9823966381	Member	Expert from Industry
7	**Dr. R. V. Hangarge** Department of Chemistry, Tai Golwalkar Mahavidyalaya, Ramtek. Mo. No. 9075641697	Member	P.G. Alumni
8	**Dr. K. I. Momin** Assistant Professor, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
9	**Dr. K. C. Tayade** Assistant Professor, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
10	**Mr. M. S. Sudewad** Assistant Professor, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Member	Faculty Member
11	**Dr. K. D. Sawant** Department of Botany , Rajarshi Shahu Mahavidyalaya, (Autonomous) Latur 413512	Member	Member from same Faculty

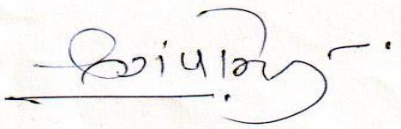
From the Desk of the Chairperson…

The Department of Chemistry was established in the academic year 1971-72. Need of Chemist, is at the forefront of the noteworthy growth in industries, the college took initiative in starting the B.Sc. Chemistry Program from 1971-72 at Undergraduate (B.Sc.) level. Now, this course is successfully flourishing the need of industries by availing Chemist with sound subject knowledge. Also, Post graduate Program in Chemistry started from Academic Year 2014-2015. From Academic Year 2023-24 we are implementing National Education Policy-2020 (NEP-2020) & Started B.Sc. (Honors/Research) Chemistry Programme to be effective from the same academic year. Department has well equipped laboratories with number of sophisticated instruments. In 2006-07, UGC recognized this department as a "Star Department" in the college and awarded CPE status.

The B.Sc. Chemistry Programme is designed to give sound knowledge and understanding of Chemistry to undergraduate students of the B.Sc. Degree course. The goal of the Programme is to make the study of Chemistry as stimulating, interesting, and relevant as possible. The curriculum is prepared with the aim of making the students capable of studying Chemistry in academic and industrial courses. Also, to expose the students to Chemistry and build up their interest in various fields of chemistry. The new and updated Curriculum is based on National Education Policy-2020 (NEP-2020) Guidelines which includes multiple entries & multiple Exit & interdisciplinary approach with vigor and depth. The curriculum is designed on the basis of Feedbacks & suggestion given by Various Stakeholders and by considering the syllabi of Competitive examination like, IIT-JAM, NET, SET, GATE examinations, UGC model curriculum, syllabi of different entrance examinations and syllabi of other Universities.

Our Vision to evolve as a world class dynamic center of higher education disseminating knowledge rigorously at affordable cost and to emerge as a premier centre that promotes technological competence and democratic values.

* "Pursuit of Excellence" in higher education to make our students globally competent.
* Enable students to develop as responsible citizens with human values.
* Provide value and need based education.
* Develop scientific attitude among students.



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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

PG Skeleton in Accordance with NEP 2020
Structure for Two Year M.Sc. Chemistry

Year Level	Sem	MMC 24-28 (22-26) per Sem 46-56 for two years		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	**Elective**		RMC 4Cr	NA	NA	20Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	**PG Diploma (After 03 Year B.Sc. Degree)**
I 6.0	**I**	MMC I 3Cr MMC II 3Cr MMC III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr						
	II	MMC IV 3Cr MMC V 3Cr MMC VI 3Cr	MEC II 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	OJT-I 4Cr /FPI 4Cr	NA	20Cr	OJT/FP: 1Cr=25M	
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**NA**	**40Cr**		
Exit Option: PG Diploma with 40 Credits After 03 Year B.Sc. Degree										
II 6.5	**III**	MMC VII 3Cr MMC VIII 3Cr MMC IX 3Cr	MEC III 3Cr	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr LC-XII 1Cr	NA	NA	RP-I 4Cr	**20Cr**	RPI & RPII: 1Cr=25M	**PG Degree (After 03 Year UG Degree)**
	IV	MMC X 3Cr MMC XI 3Cr MMC XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**MMC 36Cr**	**MEC 12Cr**	**LC-16Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**RP 10Cr**	**40+42 =82 Cr**		**82 Credits**
Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree										

Abbreviations:

1. **MMC : Major Mandatory Course**
2. **MEC : Major Elective Course**
3. **RMC : Research Methodology Course**
4. **OJT : On Job Training (Internship/Apprenticeship)**
5. **FP : Field Project**
6. **RP : Research Project**
7. **Cum. Cr : Cumulative Credit**

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Department of Chemistry

M.Sc. Botany Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Years/One Year PG (M.Sc.)

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
I 6.0	I	601CHE1101 (MMC I)	Inorganic Chemistry - I	03	45
			Lab Course-I	01	30
		601CHE1102 (MMC II)	Organic Chemistry - II	03	45
			Lab Course-II	01	30
		601CHE1103 (MMCIII)	Physical Chemistry	03	45
			Lab Course-III	01	30
		601CHE1201 MEC-I (A) Or MEC-I(B)	Physical Methods in Chemistry OR Basic Concepts of Polymer Chem	03	45
			Lab Course-IV	01	30
		601CHE1301 (RMC)	Research Methodology Course	04	100
	Total Credits			**20**	
	II	601CHE2101 (MMC IV)	Inorganic Chemistry-II	03	45
			Lab Course-V	01	30
		601CHE2102 (MMCV)	Organic Chemistry-II	03	45
			Lab Course-VI	01	30
		601CHE2103 (MMC VI)	Physical Chemistry-II	03	45
			Lab Course-VII	01	30
		MEC-I (A) Or MEC-I(B)	Physical Methods in Chemistry-II OR Molecular Spectroscopy & Comp. Application	03	45
			Lab Course-VIII	01	30
		OJT-I/Field Project (FP) 601CHE2401	OJT/ Field Project	04	120
	Total Credits			**20**	
Total Credits (Semester I & II)				**40**	

PO 1.	**Academic Competence** Possess in-depth knowledge in Chemistry and allied subjects.
PO 2.	**Scientific Outlook** Acquire a thorough knowledge about basic theoretical concepts and experimental aspects of Chemistry to identify, formulate, investigate and analyze the scientific problems.
PO 3.	**Personal and Professional Competence** Basic competence, systematic and coherent understanding of fundamental concepts in chemistry and related fields.
PO 4.	**Entrepreneurial Competence:** An opportunity to contribute effectively in the laboratory, field, and professional environments and also to grab an employment. Competency to establish independent startup/innovation center etc.
PO 5.	**Research Competence** Foster research and analytical skills in basic and applied research with the ability to undertake multidisciplinary and transdisciplinary research.

Programme Specific Outcomes (PSOs) for M.Sc. Chemistry (Honors/Research)	
PSO No.	Upon completion of this programme the students will be able to
PSO 1	Have firm foundations in the fundamentals and application of current chemical and scientific theories.
PSO 2	integrate their knowledge from each of these areas with critical thinking skills in order to become problem solvers
PSO 3	Be proficient in the chemistry laboratory, especially with respect to the abilities to follow and understand general laboratory practice guidelines, including safety. Perform qualitative & Quantitative chemical analyses. Perform chemical synthesis & Understand and use modern chemical instrumentation.
PSO 4	Find gainful employment in industry or government, be accepted at graduate or professional schools (law, medicine, etc.), or find employment in school systems as instructors or administrators.
PSO 5	Demonstrate a systematic or coherent understanding of the fundamental concepts, principles and processes underlying the academic field of chemistry, its different subfields (analytical, inorganic, organic and physical), and its linkages with related disciplinary areas/subjects;
PSO 6	Demonstrate a procedural knowledge that creates different types of professionals in the field of chemistry and related fields such as pharmaceuticals, chemical industry, teaching, research, environmental monitoring, product quality, consumer goods industry, food products, cosmetics industry, etc.;
PSO 7	Demonstrate a skills related to specialisation areas within chemistry as well as within subfields of chemistry (analytical, inorganic, organic and physical), and other related fields of study, including broader interdisciplinary subfields (life, environmental and material sciences).
PSO 8	Apply appropriate methodologies in order to conduct chemical syntheses, analyses or other chemical investigations; and apply relevant knowledge and skills to seek solutions to problems that emerge from the subfields of chemistry as well as from broader interdisciplinary subfields relating to chemistry;
PSO 9	Use chemical techniques relevant to academia and industry, generic skills and global competencies, including knowledge and skills that enable students to undertake further studies in the field of chemistry or a related field, and work in the chemical and nonchemical industry sectors.
PSO 10	Undertake hands on lab work and practical activities which develop problem solving abilities required for successful career in pharmaceuticals, chemical industry, teaching, research, environmental monitoring, product quality, consumer goods industry, food products, cosmetics industry, etc.

Semester - I

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Department of Chemistry

Course Type: MMC-I

Course Title: Inorganic Chemistry-I

Course Code: 601CHE1101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To study inorganic reaction mechanisms, SN^1 reaction, SN^2 reaction, inner and outer sphere electron transfer reactions.

LO 2. To understand the theories of Trans effect, Substitution reactions in square planar complexes.

LO 3. To know Term symbols, microstates, Correlation diagram, Orgel diagram.

LO 4. To study magnetic properties of complexes, Spin free and spin paired equilibria.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Understand inorganic reaction mechanisms, inner and outer sphere election transfer reactions.

CO 2. Apply Trans effect rule in preparation of square planar complex.

CO 3. Calculate different term symbols, microstates of metal ions.

CO 4. Gain the concepts of magnetic nature of different substance.

Unit No.	Title of Unit & Contents	Hrs.
I	**Inorganic Reaction Mechanism – I**	**12**
	1. Rate of reaction, factors affecting the rate of reactions. 2. Definition of stability constant, stepwise and overall formation constant. 3 Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. 4. Labile and inert complexes, VBT explanation of liability and inertness. 5. Ligand substitution reactions, Acid hydrolysis, factors affecting the acid hydrolysis in octahedral complexes. 6. SN1 reaction – Introduction, characteristics, explanation with example using energy profile diagram and mechanism (Dissociative	

Unit No.	Title of Unit & Contents	Hrs.
	mechanism). 7. SN2 reaction – Introduction, characteristics, explanation with example using energy profile diagram and mechanism (Associative mechanism) 8. SN^1CB reaction – Introduction, characteristics, explanation with example using mechanism.. 9. 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 Outcomes: UO 1. Write different types of inorganic reactions and their mechanism. UO 2. Define Inert and Labile complex on the basis of VBT.	
II	**Inorganic Reaction Mechanism – II**	**11**
	1. Substitution reactions in square planar complexes. Trans effect, Trans directing series 2. Theories of Trans effect – Polarization theory, Pi bonding theory, evidence in favour of trans effect theories, Defects of these theories 3. Application of trans effect in the synthesis of some square planar complexes with suitable example	
	Unit Outcome: UO 1. Discuss the role of Trans effect in Substitution Reaction of Square planar Complexes. UO 2. Define theories of Trans effect.	
III	**Spectral properties of metal complexes:**	**11**
	1. Introduction 2. Spectrochemical and nephlauxetic series 3. Charge transfer – classification, mechanism and interpretation with suitable example, Luminescence spectra 4. Term symbol, Rules for determining the ground state term symbol for dn configuration according to L-S coupling 5. Microstates – Calculation of number of microstates 6. Correlation diagram of d1 and d9, d8 in octahedral and tetrahedral field 7. Orgel diagram of d1 to d9 configuration of an octahedral and tetrahedral environment	

Unit No.	Title of Unit & Contents	Hrs.
	8. Tanabe – Sugano diagram of d2 and d3 configuration of an octahedral field 9. Racah parameter – calculation of Dq, β and B (Numericals).	
	Unit Outcomes: UO 1. Calculate the no. of Microstate for various configurations UO 2. Draw & explain Orgel diagram of d1 to d9 configuration of an octahedral and tetrahedral complexes	
IV	**Magnetic Properties of metal complexes:**	**11**
	1. Origin of magnetism, Types of magnetism, Curie Law, Curie-Weiss Law 2. Magnetic properties of complexes – paramagnetism, 1st and 2nd ordered Zeeman effect, Quenching of orbital angular momentum by ligand field 3. Magnetic properties of A, E and T ground state terms in complexes 4. Spin free and spin paired equillibria 5. Spin cross over	
	Unit Outcomes: UO 1. Determine Magnetic Susceptibility of complexes. UO 2. Derive Ground state Term symbol for Various Configurations.	

Learning Resources:

1. Puri, Sharma, Kalia Text Book Of Inorganic Chemistry, Milestone Publications-
2. W.L. Jolly , Modern Inorganic Chemistry (Mc Graw Hill Book company
3. J.E. Huheey, E.A. Keiter, R.L. Keiter Inorganic Chemistry - By Pearson
4. Gurudeep Raj, Chatwal Anand Advanced Inorganic Chemistry Goel Pub., 1974
5. Satyaprakash, G.D. Tuli, S.K. Basu, R.D.Madan, Advanced Inorganic Chemistry, S chand pulicatioin
6. Wilkinson and Cotton, Inorganic Chemistry, Wiley; Third edition
7. J. D. Lee: Fifth Edition, Concise Inorganic Chemistry, Wiley, 2008.
8. Bodie Douglas and DarlMcdaniel: Concepts and Models of Inorganic Chemistry ,Third Edition, Wiley, 1983.
9. Duward Shriver, P. W. Atkins: Inorganic Chemistry, Fifth Edition, Oxford University Press 2002

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Department of Chemistry

Course Type: MMC-I

Course Title: Lab. Course-I (Based on MMC-I)

Course Code: 601CHE1104

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. To learn about separation and estimation of binary and ternary mixture solutions.

LO 2. To understand about volumetric and gravimetric analysis of ions in binary and ternary mixture solutions.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Separate binary and ternary mixture.

CO 2. Estimate the amount of ions by volumetric and gravimetric methods of analysis in binary and ternary mixture solutions.

I	Practicals	30 Hrs
	1. 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 2. 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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Department of Chemistry

Course Type: MMC-II

Course Title: Organic Chemistry-II

Course Code: 601CHE1102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To clarify the concepts and principles of organic chemistry, types of mechanism, types of reactions, the Hammett equation etc.

LO 2. To clear the concept of aromaticity of different non-benzenoid compounds, alternant and non alternant hydrocarbons, ferrocene, etc

LO 3. Enable students to outline mechanism of Aliphatic, Nucleophilic and Aromatic substitutions reactions.

LO 4. To explain the Electrophilic and Nucleophilic addition reaction to carbon – carbon multiple bond and carbon–hetero atom multiple bond reactions.

Course outcomes

After completion of course the student will be able to-

CO 1. Understand concept of organic chemistry, different reaction mechanisms

CO 2. Identify aromatic, anti-aromatic and non aromatic compounds well.

CO 3. Able to outline the mechanisms for Aliphatic, Nucleophilic and Aromatic substitutions reactions

CO 4. Able to outline the mechanisms for Electrophilic and Nucleophilic addition reactions

Unit No.	Title of Unit & Contents	Hrs.
I	**Reaction Mechanism: Structure and Reactivity:**	**11**
	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. 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.	

Unit No.	Title of Unit & Contents	Hrs.
	3. Delocalised chemical bonding-conjugation, Cross-conjugation, Resonance, Hyperconjugation and Tautomerism. 4. Generation, Structure and stability of carbocation, carbanion, free radical, carbenes, nitrenes and arynes, strength of acids and bases.	
	Unit Outcome: UO 1. Clarify the concepts and principles of organic chemistry. UO 2. Identify the different intermediate form during reactions.	
II	**Aromaticity of Benzenoid and Non- Benzenoid Compounds:**	**12**
	1. Introduction: Concept of aromaticity, Definition, 2. Theories of aromaticity: i) Molecular Orbital Theory, ii) Resonance Theory. Huckel's $(4n+2)\pi$ electron rule of aromaticity, 3. Aromaticity in benzenoids compound, alternant and non alternant hydrocarbons 4. Aromaticity in non-benzenoid compounds, annulenes and hetero annulenes, fullerenes C60, tropane, tropoline, azulene, fulvene, tropylium salts, ferrocene. 5. Concept of anti-aromaticity.	
	Unit Outcome: UO 1. Explain the concept of aromaticity. UO 2. Identify and differentiate the aromatic, antiaromatic and non aromatic Compounds.	
III	**Substitution Reactions:**	**11**
	1. Nucleophilic Substitution: A. 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 SN1 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. 2. Aromatic nucleophilic substitution: 3. SNAr, SN^1, Benzyne and SNR1 mechanism. Reactivity: Effect of substrate, leaving group and attacking nucleophile.	

Unit No.	Title of Unit & Contents	Hrs.
	2. Electrophilic Substitution: a. Aliphatic Electrophilic Substitution. b. Bimolecular mechanism –SE^2 and $SE^{3.}$ The SE^1 mechanism, c. Electrophilic substitution accompanied by double bond shift. d. Effect of substrate, leaving group and the solvent polarity on the reactivity. e. Aromatic Electrophilic Substitution: f. The arenium ion mechanism. g. Orientation and reactivity. h. Energy profile diagrams. i. The ortho/para ratio. Ipso attack, j. Vilsmeir reaction,	
	Unit Outcomes: UO 1. Describe mechanisms for Electrophilic and Nucleophilic substitution. UO 2. Predict the effect of nucleophile, leaving group, and solvent on the relative rates.	
IV	**Addition Reactions:**	**11**
	A. Addition to Carbon – Carbon Multiple Bond 1. Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals . 2. Regioselectivity and chemoselectivity, orientation and reactivity. 3. Addition to cyclopropene ring. **B. Addition to Carbon –Hetero Multiple Bond** 1. Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles. 2. Addition of Grignard's reagent 3. Organo – zinc and organo-Lithium reagent to carbonyl and unsaturated carbonyl compounds. 4. Mannich reaction with mechanism.	
	Unit Outcomes: UO 1. Explain the Electrophilic and Nucleophilic addition reaction to carbon – carbon multiple bond. UO 2. Explain the Electrophilic and Nucleophilic addition reaction to carbon–hetero atom multiple bond reactions	

Learning Resources:

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.

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Department of Chemistry

Course Type: MMC- II

Course Title: Lab Course –II (Based on MMC-II)

Course Code: 601CHE1105

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 1. Studying experimental process of separation of the given organic binary mixture by physical method.

LO 2. Understanding the organic synthesis by single stage preparation of organic compounds.

LO 3. Studying experimental techniques such as simple distillation and thin layer chromatography for the purification and analysis of given organic compounds.

Course outcomes

After completion of course the student will be able to

CO 1. Separate the given organic binary mixture by physical method.

CO 2. Synthesize organic compounds by single stage preparation method.

CO 3. Carry out various techniques for the purification and analysis of given organic compounds.

Practical No.	Unit
1	**I) Techniques** 1 Simple Distillation. 2 Thin layer Chromatography.
2	**II) Qualitative Analysis:** Separation, purification, sample submission and identification of compounds of binary mixture (one solid and one liquid) by chemical method. (any three)

3	**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- Toluidine. 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.

N.B.: Any Ten Practicals from above.

[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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(Autonomous)

Department of Chemistry

Course Type: MMC-III

Course Title: Physical Chemistry

Course Code: 601CHE1103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1.To understands the quantum Chemistry, Postulates of quantum mechanics, approximate methods.

LO 2 .To study concepts of laws of thermodynamics – G, H, A, S etc, concept of activity & activity coefficients.

LO 3.To understand the concepts of Statistical Thermodynamics, Phase rule

LO 4.Ionic strength, Electrical double layer, Tafel equations etc.

Course Outcomes:

After completion of course the student will be able to-

CO1Understand quantum Chemistry, Postulates of quantum mechanics, the variation theorem and Perturbation theory

CO 2. Know laws of thermodynamics, Partial molar properties, Raoult's law

CO 3. Understand Partition functions, recapitulation of phase rule and terms involved in it and concepts of Electrochemistry.

Unit No.	Title of Unit & Contents	Hrs.
I	**Unit - I Quantum Chemistry**	**14**
	1.The failure of Classical Mechanics,Origin of Quantum mechanics 2 The Postulates of quantum mechanics. 3 Schrodinger equations in Laplacian and Hamiltonian form. Discussion of solutions of the Schrodinger equation to (derivations). 4. Particle in one dimensional box 5. Particle in three dimensional box. 6. Harmonic Oscillator 7. Rigid rotator 8. Hydrogen Atom 9. Orthogonality and Normalization of wave functions	

Unit No.	Title of Unit & Contents	Hrs.
	10. Operators and related theorems – Algebra of Operators, Commutator, linear operators, Hamiltonian operators, hermitian operators, Ladder operators. 11. Approximate Methods –(Any One) a) Perturbation theory (first order and non degenrate) b)Variation Method 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 Outcomes: UO 1.Distinguish between Classical mechanics & Quantom mechanics UO 2 Solve the Schrödinger equation for different model systems. UO 3. Understand the commutative property and commutation relations of operators. UO 4 .Understand the Approximation methods such as perturbation method and variation method.	
II	**Classical thermodynamics**	**11**
	1. Brief resume of concepts of laws of thermodynamics – G, H, A, S etc 2. Partial molar properties – Partial Molar volume, partial molar heat content, partial molar free energy. (Chemical potential), significances , Gibbs-Duhem equation. 3. Concept of fugacity – determination from equation of state, Duhem – Margules equation. 4. Concept of activity & activity coefficient, any one method of determination. 5. Maxwell's thermodynamic relations. 6. Ideal and non ideal solutions (Raoults law), Excess functions for non-ideal solutions.	
	Unit Outcome – **1.** Understand concepts of laws of thermodynamics. 2. Familarize partial Molar Properties & Roult's Law.	
III	**Statistical Thermodynamics and Phase Rule**	**13**

Unit No.	Title of Unit & Contents	Hrs.
	3.1 Statistical Thermodynamics: 1 .Introduction, Concept of distribution, thermodynamic probability, Ensemble and its types. 2. Partition functions – Translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions, applications of partition functions. 3. M-B, F-D and B-E statistics, Differences between them. **3.2 Phase Rule :** 1. Recapitulation of phase rule and terms involved in it, Three component system: representation of ternary systems. Partially miscible three liquid systems:- 2. System composed of three liquid components, one partially miscible pairs, two partially miscible and three partially miscible pairs. 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 Outcomes: UO 1.Understand Partition functions, recapitulation of phase rule. UO2. Explains the basic definitions and terms in a phase diagram Defines phase, equilibrium, component, degree of freedom and phase rule concepts.	
IV	**Electrochemistry**	**07**
	1. Ionic strength (problems) 2. Debye – Huckels limiting law (problems) 3. Electrical double layer – Theoreis of Helmholtz, Gouy – Chapman & stern. 4. Debye – Falkenhagen effect & wien effect. 5. Over potential & its types. 6. Exchage current density, derivation of Butler – Volmer equation, Tafel equations & Tafel plot.	
	Unit Outcomes: UO 1. Solve the Problems on Ionic strength & Mean activity Coefficient. UO 2.Understand the Concept of Electrochemistry.	

Learning Resources:

1. Physical Chemistry -P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry -A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, By: N.Levine, Prentice Hall of India (p) Ltd. New Delhi (1994).
4. Introductory Quantum Chemistry, Fourth Edition, By: A. K. Chandra : Tata McGrawHill Publishing Company Ltd., New Delhi (1994.
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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry

Course Type: MMC-III

Course Title: Lab. Course-III (Based on MMC-III)

Course Code: 601CHE1106

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1.To determine the strength, concentrations, hydrolysis constant of solutions by conductometer

LO2 .To determine pH, molar refractivity, freezing point by instrumental methods

LO3. To determine solubility, ionic strength, rate constant by non instrumental methods

Course Outcomes:

After completion of course the student will be able to-

CO1 .They can perform experiments using conductometer, PH-meter, refractometer.

CO2. They can determine solubility, ionic strength, rate constant by non instrumental method.

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

I	Practicals	30 Hrs
	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. . 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. 2. To study the variation of refractive index with composition of mixture of CCl_4 and ethyl acetate. 3. 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 1. Ethanol-water, ii) methanol-ethylidene chloride 2. Nitric acid-Chloroform and determine whether or not there is compound formation between two liquids.	

References

1. Findlay's (1985): Practical Physical Chemistry, Revised and edited by B.P. Levitt 9 th edition, Longman, London.
2. Chatwal, G.R. and Anand,S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi
3. Yadav, J. B (2005): Advanced Practical Physical Chemistry, 22 ndedition, Goel publishing House, Krishna Prakashan Media Ltd.
4. Venkatesan, V,Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry

Course Type: MEC-I

Course Title: Physical Methods in Chemistry

Course Code: 601CHE1201

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To give the knowledge regarding the data handling and basic concepts in analytical Chemistry

LO 2. To familiarize students with chromatographic separation techniques

LO 3. To give the students brief knowledge regarding forensic science

Course Outcomes:

CO 1. Students can analyse data statistically and understood the basic terms in analytical Chemistry

CO 2. Students became familiar with principles and techniques of chromatography

CO 3. Students received basic knowledge regarding forensic science.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basic Concepts of Analytical Chemistry and Chemometrics:**	12
	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 milimole iii. Stoichiometry 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	

Unit No.	Title of Unit & Contents	Hrs.
	vi. Numericals.	
	Unit Outcomes: UO 1. Analyse the data statistically and understood the basic terms in analytical Chemistry UO 2. Determine the Stoichiometry of chemical reactions.	
II	**Errors & Statistical treatment of Analytical Data**	**12**
	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 Outcomes: UO 1. Define the Errors, Accuracy and Precision. UO 2. Calculate the Average deviation & standard deviation.	
III	**Separation Techniques :**	**15**
	3.1 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, fluorimetric detectors, applications of HPLC.	
	Unit Outcomes: UO 1. Separate the mixture by using different chromatographic techniques.	
IV	**Forensic Analysis**	**06**
	4.1 Overview, Destructive and Non-destructive techniques, Data interpretation.	

Unit No.	Title of Unit & Contents	Hrs.
	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.	
	Unit Outcomes: UO 1. Define DNA Profiling. UO2.Analyze Blood Components.	

Learning Resources:

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.

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry

Course Type: MEC I

Course Title: Basic Concepts of Polymer Chemistry

Course Code: 601CHE1202

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. The graduate will be able to knowbasics concepts of polymer chemistry.

LO 2. The graduate will also be able to study various mechanisms of polymerisation and learn different techniques of polymerisation.

LO 3. The graduate will also be able to Synthesize & determine various properties.

Course Outcomes:

On completion of this course, the student will be able to:

CO1. To recall the basic concepts and classification of polymers.

CO2. To explain the basic techniques of polymerization.

Unit No.	Title of Unit & Contents	Hrs.
I	**Unit I Basic Concepts and Classification of Polymers**	**10**
	Basic concepts - polymer, monomer and polymerization, functionality and reactivity, Classification of polymers based on - source, chemical nature, thermal response, ultimate form and branched/network structures, homopolymer and copolymer (types)	
	Unit Outcomes: UO 1. Define Polymers & Polymerization UO 2. Describe Different Types of Polymers	
II	**Mechanisms & Techniques of Polymerizations**	**15**
	Mechanisms of chain and step growth polymerizations, ring opening polymerisation, Miscellaneous polymerisations - electrochemical polymerisation, metathesis polymerisation, group transfer polymerization Bulk polymerisation, solution polymerisation, suspension polymerisation, emulsion polymerisation, melt polycondensation, solution polycondensation, and interfacial polycondensation, solid and gas phase polymerisation	
	Unit Outcomes: UO 1. Discuss Different Techniques of Polymerization.	

Unit No.	Title of Unit & Contents	Hrs.
	UO 2. Describe Mechanism of Different Polymerization.	
III	**Molecular Weights and Nomenclature of Polymers**	**10**
	Degree of polymerisation, various average molecular weights (Mn, Mw, Mv and Mz) and molecular weight distribution (MWD),nomenclature of polymers based on - source, structure, IUPAC	
	Unit Outcomes: UO 1. Determination of Molecular Weight of polyper. UO 2. Nomenclature of polymers	
IV	**Commercial Polymers:**	**10**
	Manufacture, properties and applications of Polyethylene Polypropylene, polystyrene, polymethylmethacrylate, Polyvinylchloride, polybutadiene and polyacetals, PET, Nylon-6,6.	
	Unit Outcomes: UO 1. Describe Properties Polymer Defferent types of polymer. UO 2. Explain Manufacturing of Polypropylene, polystyrene, polymethylmethacrylate, etc.	

Learning Resources:

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Limited, New Delhi, 1988.
2. M. P. Stevens, Polymer Chemistry an Introduction, 2nd Edition, Oxford University Press, New York, 1999.
3. J. R. Fried,Polymer Science and Technology, Eastern Economic Edition, Printice Hall of India, New Delhi, 2000.
4. C. E. Carraher Jr Introduction to Polymer Chemistry, Special Indian Edition, Taylor and Francis, New Delhi, First reprint, 2010.
5. P. Ghosh, Polymer Science and Technology, Plastics, Rubbers, Blends and Composites, , 3rd Edition, Tata McGraw Hill Education Private Ltd., New Delhi, 2011.
6. F. W. Billmayer, Text Book of Polymer ScienceJohn Wiley and Sons, New Delhi, 1984.
7. G. Odian, Principles of Polymerisation, 3rd Edition, Odian, John Wiley & Sons (Asia) Pvt. Ltd., Singapore, 2002.
8. P. Bahadur and N. V. Sastry, Principles of Polymer Science, 2nd Edition, Narosa Publishing House, New Delhi, 2012. Course Outcomes (COs):

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry

Course Type: MEC-I

Course Title: Lab. Course-IV (Based on MEC-I)

Course Code: 601CHE1203

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. Determination of Strength of acid, base, salt using potentiometer comductometer

LO2. Determination of rate constant by using polarimeter.

Course Outcomes: Determination of

After completion of course the student will be able to-

CO 1. Determine strength of acid, base, salt using potentiometer comductometer

CO 2. Determine rate constant by using polarimeter.

I	Practicals	30 Hrs
	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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Department of Chemistry

Course Type: RMC

Course Title: Research Methodology

Course Code: 601CHE1301

Credits: 04 **Max. Marks: 100** **Lectures: 60 Hrs.**

Learning Objectives:

LO1. To enable to student to understand and work methods and concepts related Research.

LO2. To enable the student to develop research proposal and to work with research problem.

LO3. To develop broad comprehension of research area.

Course Outcomes:

After completion of course, the student will be able to-

CO1. Examine the basic aspects of Research methods

CO2. Apply and integrate the basic concepts Collection and analysis of data.

CO3. Know the of report writing and evaluation methods.

CO4. Examine the plagiarism by using various apps.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Methods of Research**	**15**
	1. Meaning of Research, Objectives of Research, Types of Research, 2. Research Approaches, Significance of Research, Research Methods Versus Methodology, Research and Scientific Methods, 3. Research Processes, Criteria for Good Research 4. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques Involved in Defining a Problem	
	Unit Outcome: UO1. Examine the basic aspects of Research methods	
II	**Research Design and Sampling**	**15**
	1. Meaning and Need for Research Design, Features of A Good Design. 2. Important Concepts Relating to Research Design: Dependent and Independent Variables, Extraneous Variables, Control, Research Hypothesis, Experimental and Non-Experimental Hypothesis –Testing Research, Experimental and Control Group	

	3. Different Research Designs: Research Design in Case of Exploratory Research Studies, Research Design in Case of Hypothesis- Testing Research Studies, Basic Principles of Experimental Designs, Important Experimental Designs 4. Sampling Design, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of A Good Sample Design, Different Types of Sample Design	
	Unit Outcome: UO1. Apply and integrate the basic concepts Collection and analysis of data.	
III	**Data Collection and Data Processing**	**15**
	1. Measurements in Research, Measurement Scales, Sources of Errors in Measurement. 2. Collection of Primary Data: Observation Method, Interview Method, Through Questionnaires, Through Schedules, Difference Between Questionnaire and Schedule 3. Collection of Secondary Data, Selection of Appropriate Methods for Data Collection, Case Study Method 4. Data Processing, Processing Operations: Editing, Coding, Classification, Tabulation, Graphical Representation, Types of Analysis, Statistical Tools and Techniques Of Data Analysis-Measures Of Central Tendency, Dispersion.	
	Unit Outcome: UO1. Know the of report writing and evaluation methods	
IV	**Report Writing and Evaluations**	**15**
	1. Principles of Report Writing and Guide Lines According to Style Manuals. 2. Writing and Presentation of Preliminary, Main Body and Reference Section of Report. 3. Evaluation of Research Report. 4. Methods to Search Required Information Effectively, Reference Management Software Like Zotero/ Mendeley, Software for Paper Formatting Like Latex/ MS Office. 5. Software for Detection of Plagiarism.	
	Unit Outcome: UO1. Examine the plagiarism by using various apps.	

Learning Recourses: -

1. Bajpai S. R. (1975) Methods of Social Survey and Research, Kitabghar, Kanpur.
2. Hans Raj (1988) Theory and Practice in Social Research, Surjeet Publication, Kolhapur.
3. Krishnaswami O. R. (1988) Methodology of Research in Social Science, Himalaya Pub. House.
4. Sadhu, Singh, Research Methodology in Social Science Bhandarkar, Research Methodology
5. Kothari, C. R. (2005) Quantitative Technique, New Delhi, Vikas Publication House.
6. Gautam, N. C. (2004) Development of Research tools, New Delhi, Shree Publishers.
7. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
8. Chandera A. and Sexena T. P. (2000) Style Manual, New Delhi, Metropolitan Book Comp. Ltd.
9. Shukla, J. J. (1999) Theories of Knowledge, Ahmadabad, Karnavati Publication.
10. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.
11. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
12. Best J. W. and Khan J. V. (2005) Research in Education New Delhi, Prentice Hall India.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-IV

Course Title: Inorganic Chemistry-II

Course Code: 601CHE2101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 4. To understand the role of natural Metalloporphyrins

LO 5. To familiarize with inorganic Raman and ESR Spectroscopy.

LO 6. To understand the chemistry of S and P block elements.

LO 4. To understand Organometallics & Solid state Chemistry.

Course Outcomes:

After completion of course the student will be able to-

CO 5. Understand the role of natural metalloporphyrins like haemoglobin, myoglobin and chlorophyll.

CO 6. Familiarize with inorganic Raman and ESR Spectroscopy and their difference.

CO 7. Understand the detail chemistry of S and P block elements w.r.t. their compounds, their reactions and applications..

CO 8. Understand the structure and bonding in Organometallics & concept of Solid state Chemistry

Unit No.	Title of Unit & Contents	Hrs.
I	**Bio inorganic Chemistry**	**11**
	1. Biological importance of essential and Non-essential elements. 2. Na / K Pump. 3. Metalloporphyrins – structure of porphyrin molecule 4. Hemoglobin – structure, function of hemoglobin., Bhor effect 5 .Myoglobin – structure and function, Difference between hemoglobin and myoglobin 6. Chlorophyll – structure and function, photosynthesis PS-I and PS-II 7. Cytochrome –structure, its types & functions 8. Electron carrier protein in biological system: Iron-suphur protein – Rubredoxin, ferrodoxin	
	Unit Outcomes:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 3. Discuss biological importance of essential and Non-essential elements. UO 4. Define the role of Hemoglobin and Myoglobin.	
II	**Inorganic Spectroscopy**	**11**
	IR Spectroscopy Principle, Difference between IR and NMR Spectroscopy, IR spectra of some inorganic compounds **Raman Spectroscopy** Principle, difference between IR and Raman spectroscopy, Raman spectra of inorganic compound. **ESR Spectroscopy** Comparison between ESR and NMR spectroscopy types of substances with unpaired electron, theory of transition metal ion as ESR indicator ion. **Mossbauer Spectroscopy** Theory, Doppler Effect, Mossbauer spectra some inorganic compounds	
	Unit Outcome: UO 3. Differentiate between IR and NMR spectroscopy. UO 4. Define theories of ESR and Mossbauer Spectroscopy.	
III	**Chemistry of Main group elements:**	**12**
	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 2. Carbon Group: C60 and its compounds (fullerenes), Intercalation compounds of Graphite, Graphene, Silicates 3. Nitrogen Group: Nitrogen activation, Oxidation states of nitrogen, phosphorus compounds 4. Oxygen Group: Oxyacids, and oxoanions of sulphur & nitrogen, comparison of strength of oxyacids 5. Halogen Group: Interhalogens, pseudohalogen, Synthesis, Structure, Properties and Application, Bonding	
	Unit Outcomes: UO 3. Discuss the Chemistry of Main group elements. UO 4. Draw & explain allotropes of Carbon.	

Unit No.	Title of Unit & Contents	Hrs.
IV	**Organometallics & Solid state Chemistry:**	**11**
	Organometallics: 1. Introduction – stable electronic configuration, 18 – electron compound, electron count preference, electron counting by oxidation states and neutral method 2. Structure and bonding of ligands carbon monoxide, Cyclopentadiene, cycloheptatriene and carbine **Solid state Chemistry:** 1. Electronic structure of solids and band theory, Limiting radius ratio, coordination number and their relationship 2. Stoichiometric defects – Introduction, schottky defect, frenkel defects. 3. Non – stoichiometric defects – metal excess defect, F-centre Interstitial ions and electrons, metal deficiency defect. Positive absent, extra interstitial negative ions. 4. Semiconductors – Introduction, N and P types of semiconductors	
	Unit Outcomes: UO 3. Calculate 18 electron compounds.. UO 4. Differentiate between Stoichiometric defects and . Non – stoichiometric defects	

Learning Resources:

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 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 andA.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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-IV

Course Title: Lab. Course-V (Based on MMC-IV)

Course Code: 601CHE2104

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. To perform semi micro qualitative inorganic analysis of three acidic and three basicradicals and synthesis of inorganic complexes.

Course Outcomes:

After completion of course the student will be able to-

CO 3. They can identify different acidic and basic radicals by qualitative analysis and prepare different inorganic complexes.

I	Practicals	30 Hrs
	Semi micro qualitative inorganic analysis (At least 08 mixtures): 1 Three acidic and three basic radicals including one rare earth metal ions and acidic radicals. 2 **Synthesis of complex:** Potassium Trioxalato Ferrate, Potassium Trioxalato Aluminate, Dimethylglyoxime Nickel(II), Tris(acetyl acetonate)Manganese(III), etc	

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-V

Course Title: Organic Chemistry-II

Course Code: 601CHE2102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. To introduce the types of free radical reactions.

LO 2. To confront students with E^2, E^1 and E^1CB mechanisms.

LO 3. To clarify the concept of pericyclic reactions and their types.

LO 4. To give perceptions about the photochemistry and their terms.

Course outcomes:

After completion of course the student will be able to-

CO 1. Became familiar with different types of free radical reactions and their applications.

CO2. Able to outline the mechanism of different E^2, E^1 and E^1CB reactions and understandtheir applications.

CO 3. Know the concepts of electrocyclic reactions, cycloaddition reactions, Sigmatropic rearrangements etc.

CO 4. Became familiar with photochemical theory, photo reduction reactions, Photo –friesreactions etc.

Unit No.	Title of Unit & Contents	Hrs.
I	**Free radical reactions**	**11**
	1. Introduction 2. Types of free radicals: a. Stable free radicals b. Short lived free radicals 3. Stability of free radicals. 4. Configuration of free radicals. 5. Mechanism of free radical reactions and applications of free radical reactions	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 1. Identify free radical reaction UO 2. Write mechanism of free radical reaction	
II	**Elimination Reaction:**	**12**
	1. The E^2, E^1 and E^1 CB mechanisms and their spectrum 2. Orientation of the double bond. 3. Reactivity: Effects of substrate structures, attacking base, the leaving group and the medium. 4. Mechanism and orientation in pyrolytic elimination.	
	Unit Outcome: UO 1. Elaborate the mechanism of elimination reactions. UO 2. Predict the effect of structure & leaving groups.	
III	**Pericyclic Reactions:**	**11**
	1. Molecular orbital symmetry. 2. Frontier orbitals of ethylene, 1,3-butadiene,1,3,5-haxatriene and allyl system. 3. Classification of pericyclic reactions. 4. Woodward Hoffmann correlation diagrams: FMO and PMO approach. **A. Electrocyclic Reactions:** 1 Conrotatory & disrotatory motions in ring opening and ring closing reactions 2 Ring opening and ring closing reactions in which polyenes having 4n, 4n+2 electron systems. **B. Cycloaddition Reactions:** 1 [2+2] Cycloaddition reactions. 2 [4+2] Cycloaddition reactions 3 1,3-dipolar cycloadditions 4 Cheleotropic reactions **C. Sigmatropic rearrangements** 1 Suprafacial and antarafacial shifts of H. 2 Sigmatropic shifts involving carbon moieties, 3,3 and 5,5-Sigmatropic rearrangements. 3 Claisen, Cope and Aza–Cope rearrangement	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1. Sketch Woodward Hoffmann correlation diagrams. UO 2. Explain the Cycloaddition Reactions, Sigmatropic rearrangements	
IV	**Photochemistry:**	**11**
	1. Principles – Photochemical theory. 2. Electronic excitation, singlet and triplet states. 3. Jablonski diagram, Energy transfer and quantum efficiency. 4. Photochemistry of carbonyl compound: Photoreduction Norrish type – I & II Paterno- Buchi reaction 5. Photochemistry of alpha, beta-unsaturated ketones. 6. Photochemistry of olefins: cis – trans isomerism. 7. Photo–Fries reaction of anilides, Barton reaction and nπ-pπ rearrangements.	
	Unit Outcomes: UO 1. Explain photochemical reactions UO 2. Familarize with photo reduction reactions, Photo –friesreactions	

Learning Resources:

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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-V

Course Title: Lab Course –VI (Based on MMC-V)

Course Code: 601CHE2105

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 4. Studying experimental process of separation of the given organic binary mixture by physical method.

LO 5. Understanding the organic synthesis by single stage preparation of organic compounds.

LO 6. Studying experimental techniques such as simple distillation and thin layer chromatography for the purification and analysis of given organic compounds.

Course outcomes

After completion of course the student will be able to

CO 1. Separate the given organic binary mixture by physical method.

CO 2. Synthesize organic compounds by single stage preparation method.

CO 3. Carry out various techniques for the purification and analysis of given organic compounds.

Practical No.	Practical
1	**1. Demonstration:** a) Steam distillation b) Column chromatography **2. Qualitative analysis:** Separation, Purification, Sample submission and Identification of compounds of binary mixture (Solids) by physical (Ether extraction) method (Any four)
2	**3. Preparations (double stage) (any three)** a) Phthalic acid ------ phthalic anhydride ---------- 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

N.B.: Any Ten Practicals from above.

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 AdwardArnold.

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-VI

Course Title: Physical Chemistry-II

Course Code: 601CHE2103

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To understand the concept of Chemical Kinetics and reaction dynamics

LO 2. To know about surface tension, Gibbs adsorption isotherm etc.

LO 3. To gain the knowledge of micelles & macromolecules.

LO 4. To familiarize students with thermodynamic and kinetic requirements of a reactions.

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Course Outcomes:

After completion of course the student will be able to

CO 1. They can understand the concept of Chemical Kinetics and reaction dynamics like ionic reactions, steady state approximation etc.

CO 2. Students know about surface tension, Gibbs adsorption isotherm, BET adsorptionisotherm.

CO 3. They gain the knowledge of micelles, CMC, macromolecules and difference betweenpolymers and macromolecules.

CO 4. They became familiarize with thermodynamic and kinetic requirements of a reactions.

Unit No.	Title of Unit & Contents	Hrs.
I	**Unit - I Chemical Kinetics and reaction dynamics**	**14**
	1. Recapitulation – Zero, first, second, third, fourth, order rate equation, molecularity & order methods of determining order of reaction, fractional order reactions. 2 .Theories of reaction rates – collision theory , TST and Lindemann theory .(in detail) 3 .Oscillatory reactions (B-Z reaction). 4. Ionic reactions – Kinetic Salt effects. 5. Enzyme catalysis :- Michaelis – Menten mechanism, limiting rate, lineweaver-burkand Eadie plots . 6. Numaricals. 7. Steady state approximation – Study of mechanism of reaction using	

Unit No.	Title of Unit & Contents	Hrs.
	chemicalkinetics, problems. 8. Kinetics of free radical and condensation polymerization.	
	Unit Outcomes: **UO 1.** Understand the concept of Chemical Kinetics and reaction dynamics like ionicreactions. **UO 2.** Solve the Problems by using steady state approximation.	
II	**Surface Chemistry**	**08**
	1. Surface tension, capillary action, pressure difference across curved surfaces (Laplaceequation). 2. Gibbs adsorption isotherm & BET adsorption isotherm, estimation of surface areafrom BET isotherm. 3. Kelvin equation for vapour pressure of droplets.	
	Unit Outcome – **1.** Predict the surface tension 2. Understand the Gibbs adsorption isotherm, BET adsorptionisotherm.	
III	**Micelles & Macromolecules**	**08**
	3.1 Micelles: 1 . Surface active agents, classification. 2. Micelles, process of Micellisation, CMC, factors affecting CMC, thermodynamicsof micellisation, cleansing action of soap & detergent. **3.2 Macromolecules:** 1. Definition, examples 2. Difference between polymers and macromolecules. 3. Types of polymers – electrically conducting, fire resistant, liquid crystal & stereoregular polymers. 4. Molecular Mass ($MN, Mw \& Mz$) Determination of Molecular Mass by –Viscometry, Osmometry & Light Scattering Method. 5. Numericals.	
	Unit Outcomes: UO 1. Identify the difference between polymers and macromolecules. UO 2. Calculate the molar mass of polymers.	
IV	**Molecular Symmetry and Group Theory**	**15**

Unit No.	Title of Unit & Contents	Hrs.
	1. Symmetry criterion of optical activity, symmetry restrictions on dipole moment. A systematic procedure for symmetry classification of molecules. 2. Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups. 3. Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. 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. 4. Applications of Group Theory. a. Determination of symmetry species for translations and rotations. b. Mulliken's notations for irreducible representations. c. Reduction of reducible representations using reduction formula. d. Group-subgroup relationships.	
	Unit Outcomes: UO 1. Predict the point groups of molecule . UO 2.Determine the Translational , Vibration and Rotational modes .	

Learning Resources:

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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MMC-VI

Course Title: Lab. Course-VII (Based on MMC-VI)

Course Code: 601CHE2106

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To determine equilibrium quotient, concentration of in by colorimeter.

LO 2. To determine pK_1, pK_2 values, oxidation state of metal ion by potentiometer.

LO 3. To find out molecular weight, surface tension, order of reaction.

Course Outcomes:

After completion of course the student will be able to-

CO1. They can determine equilibrium quotient, concentration of in by colorimeter.

CO2. Students can determine PK1 PK1 values, oxidation state of metal ion by potentiometer.

CO3. They can find out molecular weight, surface tension, order of reaction, 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 solution

I	Practicals	30 Hrs
	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 EDTAsolution. **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 andhence to calculate atomic parachors of C, H, Cl. 4. To determine order of reaction of given reaction kinetics by fractional changemethod. 5. To study distribution of benzoic acid between benzene and water at roomtemperature and hence show that benzoic acid dimerises in benzene.	

References

1. Findlay's (1985): Practical Physical Chemistry, Revised and edited by B.P. Levitt 9 th edition, Longman, London.
2. Chatwal, G.R. and Anand,S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi
3. Yadav, J. B (2005): Advanced Practical Physical Chemistry, 22nd edition, Goel publishing House, Krishna Prakashan Media Ltd.
4. Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.

Shiv Chhatrapati Shikshan

Sanstha's **Rajarshi Shahu**

Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical

Chemistry Course Type: MEC-II

Course Title: Physical Methods in

Chemistry-II Course Code: 601CHE2201

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To familiarize students with electrochemical methods of analysis.

LO 2. To confront students with spectroscopic methods of analysis.

LO 3. To describe students about principle and techniques of thermal methods.

LO 4. To confront students with principle and techniques of X-ray diffraction (XRD).

Course Outcomes:

CO 1. Student will become familiarize with principles of polarography & voltametry

CO 2. Students will receive knowledge about principle and techniques of atomic absorption spectroscopy & flame photometry.

CO 3. Students will receive knowledge about principle and techniques of thermal methods o analysis.

CO 4. Students will understand principle and techniques of X-ray diffraction (XRD) methods.

Unit No.	Title of Unit & Contents	Hrs.
I	**Electroanalytical Techniques:**	13
	1.1 Polarography & Voltametry Principle of polarography, instrument polarographic measurement, DME, polarogram, Half wave potential, currents contributing to polarographic wave, departure of polarographic waves, conditions for performing polarographic determination. Applications of polarography, modified polarographic techniques, Voltammetry, cyclic voltammetry, stripping voltammetry, Hydrodynamic voltammetry, Numerical **1.2 Electrogravimetry :** Theory, Important terms used in electrogravimetric methods, overpotential, electrogravimetric methods, instrumentation	

Unit No.	Title of Unit & Contents	Hrs.
	electrolysis using mercury cathode, spontaneous or internal electrolysis, determination of metal by constant current procedure, determination of metal by controlled potential methods, electrography	
	Unit Outcomes: UO 1. Discuss and explain polarographic and voltammetric method of analysis. UO 2. Elaborate principle and techniques of electrogravmetric Methods.	
II	**Spectroscopic techniques**	**10**
	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 Emission 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 Outcomes: UO 1. Outline and explain principal and instrumentation of AAS. UO 2. Outline and explain principal and instrumentation of FES.	
III	**Thermal Methods**	**10**
	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.	

Unit No.	Title of Unit & Contents	Hrs.
	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 Outcomes: UO 1. Discuss the principle working and instrumentation of thermal methods of analysis. UO 2. Interpret thermographs	
IV	**Diffraction Methods :**	**12**
	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, identification of unit cells from systematic absences in the diffraction pattern, structure of simple lattices and X-ray intensities, structure factor and its relation to intensity of electron density.	
	Unit Outcomes: UO 1. Explain various diffraction methods of analysis UO2.Draw various lattice planes and explain them with studied laws	

Learning Resources:

1. Instrumental methods of chemical analysis (CBS) – H.H. Willard & L.L. Merritk, I.A. Dean.
2. Instrumental methods of Analysis – Chatwal Anand.
3. Instrumental methods of chemical analysis – H. Kaur.
4. Fundamental Analytical Chemistry 8th edition – Skoog, west, holler, couch.
5. Analytical Chemistry 6th edition – L.D. Christain.
6. Principal of Analytical Chemistry, Douglas & Koog, F.I. Holler & R.crouch 6th Edition, Thomson books/cole 2007.
7. Instrumental Methods of Chemical Analysis – B.K. Sharma
8. Instrumental methods of Chemical Analysis – R.D. Braun.
9. Basic principles of spectroscopy – R Chang, Mc. Graw Hill.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical Chemistry

Course Type: MEC-II

Course Title: Molecular Spectroscopy & Computer Application-II

Course Code: 601CHE2201

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To gain the knowledge regarding the Basic Concepts in Molecular Spectroscopy

LO 2. To familiarize students with, Infrared & Microwave Spectroscopy's

LO 3. To acquaint students with knowledge of Electronic & Raman Spectroscopy

LO 4. To train the students about brief application of computer in chemistry

Course Outcomes:

After completion of this course students will be able to:

CO 1. Explain Basic Concepts in Molecular Spectroscopy

CO 2. Apply Infrared & Microwave Spectroscopy's

CO 3. Solve the problems based on Electronic & Raman Spectroscopy

CO 4. Use the computer to solve the chemistry related problems

Unit No.	Title of Unit & Contents	Hrs.
I	**Basic Principles of Spectroscopy**	**5**
	1. Characterization of electromagnetic radiation, quantization of energy. 2. Regions of the spectrum, interaction of radiation with molecular systems & types of molecular energies. 3. Factors affecting width and intensity of spectral lines, selection rule, general discussion on various molecular excitation processes	
	Unit Outcomes: UO 1. Gain the knowledge regarding the Basic Concepts in Molecular Spectroscopy	

II	Microwave spectroscopy & Infrared spectroscopy	15
Unit No.	**Title of Unit & Contents**	**Hrs.**
	1. Microwave spectroscopy Classification of molecules according to their moment of inertia, rigid rotor model, effect of isotopic substitution on the transition frequencies, stark effect, non-rigid rotor, selection rules, mechanism of interaction, spectra of symmetric and asymmetric top molecules, applications of microwave spectroscopy. **2. Infrared spectroscopy** Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and band strengths, unharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, PQR branches, Breakdown of Oppenheimer approximation, vibrations of polyatomic molecules, selection rules, normal modes of vibrations, overtones, hot bands, finger-print region, functional group identification.	
	Unit Outcomes: UO 1. To familiarize students with, Infrared & Microwave Spectroscopy	
IV	**Raman Spectroscopy & electronic spectroscopy**	**15**
	1. Raman Spectroscopy Classical and quantum theory, Raman effect, Stokes and anti-stokes lines, pure rotational, vibrational and rotation-vibration Raman spectra, selection rules, mutual exclusion principles, structure determination of di , tri and tetra-atomic molecules from Raman and IR spectra, effect of polarization of light. **2. Electronic spectroscopy** Atomic transitions, spin orbit interaction, atom in uniform magnetic field, many electron atoms, spectra of alkali/alkaline earth atoms, molecular electronic transition, vibrational coarse structure, intensity/selection rule, Frank-Condon Principles, ground and first excited electronic states of diatomic molecule, dissociation energy and dissociation products, rotational fine structure, Fortrat diagram, pre-dissociation	

	Unit Outcomes: UO 1. To familiarize learners with electronic and Raman spectroscopy	
IV	**Computer Application**	**10**
Unit No.	**Title of Unit & Contents**	**Hrs.**
	1 Overview of computer, operating system and programming languages. 2 Introduction to chemometric and cheminformatic methods and applications in solving chemical problems. 3 Application of ChemDraw & Chemsketch . 4 Fragment code, linear notation, SMILES and connection table 5 Chemical structure databases. 6 Molecular similarity and structural searching.	
	Unit Outcomes: UO 1. Educate students about skills to utilize a computer in Chemistry.	

Shiv Chhatrapati Shikshan

Sanstha's **Rajarshi Shahu**

Mahavidyalaya, Latur

(Autonomous)

Department of Chemistry and Analytical

Chemistry Course Type: MEC-II

Course Title: Lab. Course-VIII (Based on MMC-II) Course Code: 601CHE2106

Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Note:

1. Performance of eight experiments is expected
2. At least one experiment on each instrument should be done.
3. Students 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 (Instrumental)

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 behavior 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 Fe3+ 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

Thermal Analysis:

1. Recording and interpretation of Thermogravimetric Curve of the given sample.

X-ray Diffractometer:

1. To record X-ray diffraction pattern of NaCl and its interpretation.

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.
4. Separation of mixture of amino acids by paper chromatography.

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.

Reference:

1) Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education,2012.
2) Analytical Chemistry 6th edition – L.D. Christain
3) Practical Book of Analytical Chemistry (First Edition), Ms.Pooja R. Popat, Publisher Notion Press
4) Systematic Experimental Physical Chemistry, S.W. Rajbhoj and T.K. Chondekar, Anjali Publication (2013).
5) Advanced Experimental Chemistry volume - I, J.N. Gurtu R. Kapoor, S. Chand and Co. New Delhi.
6) Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson,2009.
7) College Practical Chemistry (Mumbai Univ), D.S. Pimple, H.N. Patel, K.P. Jain, R.S. Yamgar, S. P. Turakhia, S. R. Puniyani, Himalaya Publishing House
8) Post Graduate Practical Chemistry (MSc I), G.C. WADHAWA, H.N. Patel, K.P. Jain, R.S. Yamgar, S. P. Turakhia, S. R. Puniyani, SAJID F. SHAIKH, Himalaya Publishing House
9) De Anil. K. (2011). Environmental Chemistry- 3rd edition. Wiley Eastern Ltd.
10) Jahagirdar D.V. (2003). Experiments in Chemistry. Himalaya Publication
11) Homes & Peck. (1983). Analytical Biochemistry. Prentice Hall-3rd edition

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerne mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.

4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.

All claims for the credits by the students should be made and approved by

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

PG First Year

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken Tutorial Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

4. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
5. Maximum 04 extra credits in each academic year will be allotted.
6. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

5. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
6. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
7. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
8. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

6. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
7. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
8. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
9. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
10. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

4. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
5. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
6. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

4. The respective documents should be submitted within 10 days after completion of Semester End Examination.
5. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
6. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
7. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
8. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
9. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
Research Methodology	100	10	10	20	10	-	-	40	60	100
DSC/DSE	75	05	10	15	10	-	-	30	45	75
Lab Course	50	-	-	-	-	05	20	-	25	50
Field Project	100	10	10	20	10	-	-	40	60	100

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.