Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

CIRCULAR NO.SU/Sci. & Tech./University Deptt./NEP/15/2023

It is hereby inform to all concerned that, the syllabi prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted **the following curriculum of All Post Graduate Degree Courses as per Norms of National Education Policy – 2020 under the Faculty of Science & Technology run at University Department, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Syllabi of Department of BAMU, Aurangabad.	Semester
1.	M.Sc.Chemistry specialization Inorganic Chemistry, Organic Chemistry, Physical Chemistry and self supported Analytical Chemistry	Ist and IInd Semester
2.	M.Sc.Statistics	Ist and IInd Semester
3.	M.Sc.Mathematics	Ist and IInd Semester
4.	M.Sc.Physics	Ist Semester
5.	M.Sc.Food Technology	Ist and IInd Semester
6.	M.Sc.Drug Intermediates Technology	Ist and IInd Semester
7	M.Sc. Information Technology	Ist to IVth Semester
8.	M.Sc.Computer Science	Ist to IVth Semester
9.	M.Sc.Botany	Ist and IInd Semester
10.	M.Sc.Enviornmental Science	Ist and IInd Semester
11.	M.Sc.Artificial Intelligence.	Ist to IVth Semester
12.	M.Sc.Biochemistry	Ist and IInd Semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/NEP/2023/ 8743-51
Date:- 08.08.2023.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **Head of the Department, All Departments, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.**
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.**
2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
6] The Public Relation Officer, Dr.BAMU,A'bad.
7] The Record Keeper, Dr.BAMU,A'bad.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

NAAC Re-accredited 'A' Grade

Department of Chemistry

FACULTY OF SCIENCE & TECHNOLOGY

Two Years P.G. Programme in Chemistry

(M. Sc. Chemistry Semester I & II)

As Per National Education Policy-2020

(To be implemented from Academic Year 2023-24)

Course structure and Curriculum

(Outcome Based Credit System)

Subject : Chemistry

Effective from 2023-24

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

INDEX		
Sr. No.	**Contents**	**Page No.**
1.	Preface	03
2.	Vision of Department	04
3.	Mission of Department	04
4.	Programme Educational Objectives	04
5.	Program Outcomes	04
6.	Course Program outcome	04-05
7.	Curriculum	06-

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

PREFACE

National Education policy 2020 has been intensely debated policies come into existence. In January, 2020 UGC has given the guideline for Learning outcome based curriculum framework (LOCF)work towards more holistic experience for the students . while focussing not just on knowledge delivery in higher education but also on the application of knowledge through field and laboratory work and emphasis on application of knowledge to real life experiences, LOCF is student-centric education in the context of development of personal, social, professional and acquired knowledge requirements in their career and life building, which focuses on measuring student performance through outcomes. It includes the knowledge, skills and attitudes enhancement in the students .

The aspects of LOCF is all-round development of the students, skill acquisition outside chosen subjects and research were undetermined but NEP has changed all of these in one stroke. The prominent features of the NEP framework are:

- Student centric education
- Flexibility in postgraduate programmes
- Multiple entry and exit points
- Skill based & outcome base education
- Credit based evaluation system
- Academic bank credits

It also focuses on evaluation of outcomes of the program by considering the knowledge, skill and behaviour of a students after completion of two year program. The educational triangle of Teaching-Learning and Evaluation process is the unique features of the OBE approach. The curriculum practices such as Competency based curriculum, Tailor-made curriculum development, spades, curriculum principles, Blooms Taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models /approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidence based education systems approach, etc as the scientific and systematic approaches in curriculum design.

Maharashtra state government and the authorities of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad has decided to implement National Education policies -2020 from the academic year 2023-24 for postgraduate program with outcome based education

As per guideline of OBE the department has prepared curriculum for Master of science in chemistry with specialization Inorganic chemistry, Organic Chemistry, Physical Chemistry and self supported Analytical Chemistry . The OBE syllabus will help to improve the quality and employability of the Post-graduates of the university department.

Professor &Head
Department of Chemistry
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

1. **Vision of Department :**
A respectable teaching- learning and research organization nationally and internationally in the area of chemical sciences by providing competitive trained chemists which will assist the chemical world, industries and stake holders.

2. **Mission Department :**
   - To bring sustainable progress of society by nurturing chemistry with responsibilities
   - To create and maintain programs of excellence in the areas of research , education and public outreach
   - Department will produce students who are knowledge in chemistry and can think critically.
   - To develop the researcher and scientist in chemical science through post-graduate education and research programme.
   - To develop the competent manpower with technology based experimentation methodologies and value based practices for business and industries.
   - To undertake projects to solve field base problems.
   - To provide student centric learning facilities for the development of overall personality of learner.

3. **Eligibility Criteria :**

4. **. Assessment and Evaluation :**

5. **. Duration of Course Programme : Two years**

6. **. Credit Allotted for two year master programme in chemistry :** 88 Credit

   . Semester - I : 22

   . Semester -II : 22

   . Semester -III : 22

   . Semester -IV : 22

7. **. Program Educational Objectives:**
The program educational objectives (PEO's) are the statement that describes the career and professional achievement after the program of studies (post-graduation). The PEO' s are driven form the Mission statement (What is the purpose of organization). The PEO's can be minimum three and maximum five.

   PEO1: To have advanced knowledge of chemistry domain.

   PEO2: To provide the professional services to industry, Research organization and institutes.

   PEO3: To provide the professional consultancy and research support for therelevant organization in the domain of super specialization.

   PEO4: To opt for higher education, disciplinary & multi-disciplinary research and to

   be a life-long learner.

   PEO5: To provide, value based and ethical leadership in the professional and social life.

8. **Program Outcomes:**

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

The program outcomes (PO's) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the post-graduate will have by the end of program studies.

i).In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.

ii). Apply/implement interface between on the one hand, the history of chemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.

iii). Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.

iv). Skill in examining specific phenomena theoretically and/or experimentally.

v). Generation of new scientific insights or to the innovation of new applications of chemical research.

9. **Course Program outcome**

Course Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, **"To which POs his/her course is contributing?"**. So that one can design the learning experiences, select teaching method and design the tool for assessment.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

M.Sc. First Year Semester-I Course Structure

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned			Marks		
			Theory	Practical	Theory	Practical	Total Credits	Conti. Inter. Assmen.	End. Sem Exam	Total Marks
Major Mandatory DSC	CHTC-500	DSC-1 Anal. Chem	2	-	2	-	8T	20	30	50
	CHTC-501	DSC-2 Inorg. Chem	2	-	2	-		20	30	50
	CHTC-502	DSC-3 Org. Chem	2	-	2	-		20	30	50
	CHTC-503	DSC-4 Phy. Chem	2	-	2			20	30	50
	CHLC-504	DSC-5 Inorg. Chem. Lab course	-	4	-	2	6L	20	30	50
	CHLC-505	DSC-6 Org. Chem. Lab course	-	4	-	2		20	30	50
	CHLC-506	DSC-7 Phy. Chem. Lab course	-	4	-	2		20	30	50
DSE (Choose one from your specialization and any one from remaining three)	CHTE-507	DSE-1 Anal. Chem	2	-	2	-	4T	20	30	50
	CHTE -508	DSE -2 Inorg. Chem	2	-	2	-		20	30	50
	CHTE -509	DSE -3 Org. Chem	2	-	2	-		20	30	50
	CHTE -510	DSE -4 Phy.Chem	2	-	2	-		20	30	50
Research methodology	CHRM-511	Research methodology	4	-	4	-	4T	40	60	100
Total			**16**	**12**	**16**	**06**	**22**	**220**	**330**	**550**

Course Code Nomenclature :

DSC-Discipline Specific Core, **DSE**- Discipline Specific Elective, **T**-Theory, **L**- Laboratory course, **CHTC**- Chemistry Theory Core , **CHLC**- Chemistry Laboratory Core , **CHTE**- Chemistry Theory Elective , **CHRM**- Chemistry Research Methodology

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

M. Sc. First Year Semester- I : Course code, Course Name Teaching Hrs, Credit assigned CIA & ESE & Total marks

Sr. No	Course Code	Course Name	Teaching (Hrs./ week)	Credits Assigned	Conti. Inter. Assmen. (Marks)	End. Sem Exam (Marks)	Total Marks
DSC-Major Mandatory							
1.	CHTC-500	Analytical Chemistry- I	2	2	20	30	50
2.	CHTC-501	Molecular symmetry and Group theory	2	2	20	30	50
3.	CHTC-502	Organic Chemistry- I	2	2	20	30	50
4.	CHTC-503	Physical Chemistry-I	2	2	20	30	50
5.	CHLC-504	Inorganic Chemistry Laboratory Course	4	2	20	30	50
6.	CHLC-505	Organic Chemistry Laboratory Course	4	2	20	30	50
7.	CHLC-506	Physical Chemistry Laboratory Course	4	2	20	30	50
DSE-(Choose one from your specialization and any one from remaining three)							
8.	CHTE-507	Analytical Chemistry- II	2	2	20	30	50
9.	CHTE -508	Inorganic Chemistry- I	2	2	20	30	50
10.	CHTE -509	Stereochemistry	2	2	20	30	50
11.	CHTE -510	Physical Chemistry-II	2	2	20	30	50
Research methodology							
12.	CHRM-511	Research methodology	4	4	40	60	100
Total			**28**	**22**	**220**	**330**	**550**

Course Code Nomenclature :

DSC-Discipline Specific Core, **DSE**- Discipline Specific Elective, **T**-Theory, **L**- Laboratory course, **CHTC**- Chemistry Theory Core , **CHLC**- Chemistry Laboratory Core , **CHTE**- Chemistry Theory Elective , **CHRM**- Chemistry Research Methodology

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : I

Course Name: Analytical Chemistry - I **Course Code: CHTC-500**

Course type : DSC-1 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning objectives :

1. To understand why analytical measurements need to be made.
2. To understand the importance of producing reliable results.
3. To be able to define what is meant by 'quality'.
4. To understand the importance of sampling and able to identify different types of samples.
5. To understand the basics in each separation techniques, *viz.*crystalization, sublimation, distillation, extraction.
6. To understand the theory of liquid-liquid extraction.
7. To understand the theory of solid-phase extraction.
8. To understand basic of chromatographic Techniques for separation of constituents of mixtures
9. To understand rate and plate theory of chromatography.
10. To be able to define the factores broadening a zone of a chromatogram.

Unit-I : Basic concepts of analytical chemistry **10Hrs**

The role of analytical chemistry, The analytical perspectives, Common analytical problems, Purpose of analysis, Types of analysis, Qualitative and quantitative analysis, The analytical process, Steps in an analysis, Sampling: Types of samples and sampling, Introduction to the validation of a method

Unit-II : Basic separation techniques **10Hrs**

Precipitation, Recrystallization, Sublimation, Distillation: Simple, Fractional, Steam distillation, Distillation under vacuum, Theory of operation of distillation methods, Some practical considerations.
Solvent and Solid Phase extraction: Phase equilibrium, The partition coefficient, The distribution ratio, Percent extracted, Theory of phase contact methods: Single equilibrations, Repeated equilibrations, Counter current distribution, Practical aspects and applications - Extraction of metals, Extraction of molecular species, Ion pair extractions, Accelerated and microwave assisted extraction, Solid phase extraction, Numericals

Unit-III : Chromatography **10Hrs**

Introduction, Elution, Eluent, Retention time, Retention volume, Retention ratio, Basic principles and theory of chromatographic techniques, Plate theory of chromatography, Rate theory of chromatography, Other factors in zone broadening, Development of the chromatogram: Frontal analysis, elution analysis displacement analysis, Selection of chromatograph system,

Qualitative and quantitative analysis by chromatography.

References Books

1. Analytical Chemistry 6th Edition., Gary D. Christian
2. Fundamental of Analytical Chemistry 8th Ed^{n}. Skoog, West Hollar, Crouch
3. Chemical Separations and Measurements, D.G. Peters, J.M. Hayes and G.M. Hieftie
4. Instrumental Method of Chemical Analysis, G.R. Chatwal & S. K. Anand
5. Introduction to instrumental analysis – Robert D. Braun

Course Outcome: At the end of this course, students will-

1. understood why analytical measurements need to be made.
2. understood the importance of producing reliable results.
3. defined what is meant by 'quality'.
4. understood the importance of sampling and able to identify different types of samples.
5. understood the basics in each separation techniques, *viz.* crystalization, sublimation, distillation, extraction
6. understood the theory of liquid-liquid extraction
7. understood the theory of solid-phase extraction.
8. understood basic of chromatographic Techniques for separation of constituents of mixtures
9. understood rate and plate theory of chromatography.
10. defined the factores broadening a zone of a chromatogram.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : I

Course Name: Molecular symmetry and group theory **Course Code:**CHTC-501

Course type : DSC-2 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

11. To understand how to perform symmetry operation to chemical molecules.
12. To identify the symmetry elements based on structure of molecules.
13. To apply the knowledge of concept of symmetry element and operations and centre, axis and planes symmetries possessed by an object / orbitals / molecule.
14. To identify & classify of point group of molecules
15. To apply knowledge of group theory to understand properties of molecules, character of matrix, product of symmetry operations, reducible and irreducible representations.
16. To use knowledge of character of representations to designate appropriate Mulliken symbols.
17. To calculate the appearance of irreducible representation by correlating relation between IRs, RRs and order of group.
18. To evaluation of predict the product of symmetric and asymmetric representations and evaluate new irreducible representation.
19. To identify modes of molecular vibrations of chemical compounds.

Unit-I :Group theory and Symmetry concepts **10Hrs**

Symmetry elements and symmetry operations, Centre of symmetry(i), Axis of symmetry(C_n), Plane of symmetry (σ_v, σ_h, σ_d), Rotation reflection axis of symmetry(Sn), Identity(E). Point groups, Classifications of point groups, Identification of point group of : H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_3, PCl_5, $[PtCl_4]^-$, cis and trans $[PtCl_2(NH_3)_2]$, $[CoCl_2(NH_3)_4]$, $[FeF_6]$, H_2, HCl, CO, BeF_2, $C_2H_2Cl_2$,C_6H_6, and substituted benzene molecule. Application of point group with respect to dipole moment, polar and non polar molecules.

Unit-II :Representations of groups **10Hrs**

Group, Properties of group, Group multiplication tables, Matrix representation of symmetry elements. Reducible representation, Generation of reducible representation for H_2O, NH_3, $POCl_3$, CH_3Cl ,Matrix

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

representation for symmetry operations, Character of representation, Character of p, and d orbital representations.

Unit-III : Application of character tables **10Hrs**

Character table, Rules for construction of character tables. Construction of character table for C_{2v} & C_{3v} point group. Mulliken symbolism rules for irreducible representations. Reduction formula, Reducing representations to Irreducible Representations with examples, Direct product of irreducible representation, Molecular vibrations, Modes of vibrations, calculation IR active modes of vibrations with examples.

References Books

6. Symmetry and Spectroscopy of Molecules- K.Veera Reddy.
7. Group Theory and its Chemical Application- P.K. Bhattarchrya
8. Inorganic Chemistry - Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, 5th Edn
9. Inorganic Chemistry- J.E.Huhey and Keiter R. L
10. Principle of Inorganic chemistry-Brian W. Pfennig .
11. Inorganic Chemistry – Shriver & Atkins
12. Symmetry and Group theory in Chemistry- R Ameta
13. Group Theory and symmetry in Chemistry- Gurdeep Raj .AjayBhagi and Vinod Jain.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : I

Course Name: Organic Chemistry - I **Course Code:CHTC-502**

Course type : DSC-3 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Course Objectives

Student will be able to

20. Understand the chemical and molecular processes in organic chemical reactions.
21. Study the concept of Alternant and non-alternant hydrocarbons
22. Study the energy levels of π-molecular orbitals
23. Explain the concept of aromaticity
24. Know the types of mechanism in organic reactions
25. Understand the correlation between the thermodynamic and kinetic parameters
26. Study the different intermediates involved in organic chemical reactions
27. Learn the various types of aliphatic nucleophilic substitution reactions

Unit-I :Nature of Bonding in Organic Molecules **10 Hrs**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non- alternant compounds, Huckel rule, energy level of π-molecular orbitals, annulenes, aromaticity, Bonds weaker than covalent - addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

Unit-II :Reaction Mechanism: Structure and Reactivity **10 Hrs**

Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammond's postulate, methods of determining mechanisms, isotope effects.

Generation, structure, stability and reactivity of carbocations, Carbanions, free redicals, carbenes and Nitrenes. Effect of structure on reactivity, resonance and field effect, steric effect quantitative treatment, The Hammett equation, Linear free energy relationship, substituent and reaction constants, Taft equation.

Unit-III :Aliphatic Nucleophilic Substitutions **10 Hrs**

Nucleophilic: The SN^2, SN^1 mixed SN^1 and SN^2 and SET mechanisms. The neighbouring group mechanism, Neighbouring group participation by π and σ-bonds, anchimeric assistance. Nucleophilic Substitution at an allylic aliphatic trigonal and a vinylic carbon.

Reactivity: Effect of substrate structure, attacking nucleophile, leaving group, Reactivityand reaction medium. Phase transfer catalysis, Ambident nucleophiles, regioselectivity.

Course Outcome :

After completion of the course, students will be able to

14. Explore conceptual fact of chemical bonding and basis of reactivity
15. Apply the concept of aromaticity to various molecules
16. Explain the types of reactions and reaction intermediates
17. Compare the SN^1, SN^2 and SN^i with respect to mechanism, orientation and

stereochemical outcome

18. Differentiate various nucleophilic substitution reactions
19. Explore conceptual fact of chemical bonding and basis of reactivity

References Books

1. Advanced Organic Chemistry, IV Edition: J. March
2. Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg
3. A Guide Book to Mechanism in Organic Chemistry: Peter Sykes
4. Synthetic Organic Chemistry: H. O. House
5. Principles of Organic Synthesis: R. O. C. Norman
6. Organic Chemistry (Second Edition): Clayden, Greeves and Warren
7. Mechanism and Structure in Organic Chemistry: E. S. Gould

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester: I

Course Name: Physical Chemistry-I **Course Code: CHTC-503**

Course Type: DSC-4 **2 Hrs/ Week**

Total Contact Hours: 30 **Theory Credit:** 2 **Marks** : 50

Course Objectives:

1. To understand the fundamental principles of chemical kinetics.
2. To learn different theories of chemical kinetics.
3. To understand concept of fast and slow reactions based on their rate constant and reaction rates.
4. To understand the concept of thermodynamics.
5. To apply critical thinking and problem solving skills to solve problem related to thermodynamics and chemical kinetics.
6. To understand the basic concept of micelles.

Unit-I: Chemical Dynamics **10 Hrs**

Collision theory, modified collision theory, weakness of the collision theory, Theory of absolute reaction rates, equilibrium hypothesis, Derivation of the rate equation, statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate. Primary salt effect, secondary salt effect. Dynamics of uni-molecular reactions, Lindmann and Hinshelwood theory, Kinetics of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and NMR method.
Reactions in solution: Reaction between ions, influence of solvent-double sphere model, single sphere model, influence of ionic strength, numericals.

Unit-II: Classical Thermodynamics **10 Hrs**

Nernst heat theorem, the third law of thermodynamics, determination of absolute entropies of solids, liquids and gases. Partial molar properties : Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity.

Unit-III: Micelles **10 Hrs**

Colloidal electrolytes, Types of micelles in colloidal electrolytes, Micellization, Thermodynamics of micellization, Mechanism of Micellization, critical micellar concentration, Determinations of critical micellar concentration, Surface active agents, Classifications of surface active agents, Reverse micelles, Solubilization

Reference Books:

1. Chemical Kinetics - Laidler (McGraw-Hill)

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

2. Kinetic and Mechanism of Chemical Transformations - J. Rajaram and J.C. CURIACOSE (Macmillan India Ltd.)
3. Physical Chemistry - Atkins (Oxford)
4. Thermodynamics for Chemists - S. Glasstone (EWP, New Delhi)
5. Physical Chemistry - G. M. Barrow
6. Advanced Physical Chemistry - Gurdeep-Raj (Pelenum)
7. Micelles : Theoretical and Applied Aspects - V. Moroi (Plenum)
8. Text Book of Physical Chemistry - S. Glasstone (McMillan)
9. Physical chemistry – Robert A .Alberty ., Robert J .Silbey
10. Statistical Thermodynamic – M. C. Gupta

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : I

Course Name: Inorganic Chemistry Laboratory Course **Course Code:CHLC-504**

Course type : DSC-5 **4 Hrs/ Week**

Total contact hours :60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. To understand the difference between qualitative and quantitative analysis.
2. To understand the concept of qualitative and quantitative chemical analysis and their chemical reactions and constituents .
3. To understand the design and development of experimental setup and procedure, for volumetric and gravimetric analysis of chemical compound.
4. To identify constituents of chemicals qualitatively and quantitively
5. To understand importance of accuracy and precision in measurement of chemical analysis
6. To apply grasped knowledge to solve chemical analysis related issues of stakeholder.
7. To understand importance of laboratory skills, precaution, accuracy and precision.
8. To separate and identify acidic & basic radicals from chemical sample.
9. To apply the grasped knowledge in chemical analysis of unknown sample.

List of experiments

Sr No **Group- I (Any 3)**

1. Separation and Identification of three basic radicals from II group sample mixture by semimicro qualitative analysis method and their chemical reactions .
2. Separation and Identification of three basic radicals from III-A group sample mixture by semimicro qualitative analysis method and their chemical reactions .
3. Separation and Identification of three basic radicals from III-B group sample mixture by semimicro qualitative analysis method and their chemical reactions .
4. Separation and Identification of three basic radicals from IV group sample mixture by semimicro qualitative analysis method and their chemical reactions
5. Separation and Identification of three basic radicals from special group sample mixture by semimicro qualitative analysis method and their chemical reactions .

Group- II (Any 3)

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

6. Separation and Identification of three basic radicals from II, IIIA and IIIB groups sample mixture by semimicro qualitative analysis method and their chemical reactions .
7. Separation and Identification of three basic radicals from IIIA , IIIB & IV groups sample mixture by semimicro qualitative analysis method and their chemical reactions.
8. Separation and Identification of three basic radicals from IIIA , IIIB & V groups sample mixture by semimicro qualitative analysis method and their chemical reactions.
9. Separation and Identification of three basic radicals from IIIA , IV & special groups sample mixture by semimicro qualitative analysis method and their chemical reactions .

Group- III (Any 3)

10. Identification of Carbonate, Chloride Iodide and Acetate, ions from given mixture by semimicro qualitative analysis method along with chemical reaction of each radicals.
11. Identification of Nitrate, Phosphate, Oxalate and Sulphate ions from given mixture by semimicro qualitative analysis method along with chemical reaction of each radicals.
12. Identification of the Chloride , Bromide , Iodide and Acetate ions from given mixture along with chemical reaction of each radicals.
13. Identification of Phosphate , Oxalate , thiosulphate and Acetate ions from given mixture by semimicro qualitative analysis method along with chemical reaction of each radicals.
14. Identification of Carbonate , Nitrate , Oxalate and thiosulphate ions from given mixture by semimicro qualitative analysis method along with chemical reaction of each radicals.

Group- IV (Any 3)

15. Qualitative analysis of metal ions present in soil sample.
16. Determine the temporary and permanent hardness of given sample of water
17. To determine the percentage of phosphate as Phosphorous in chemical fertilizer Ammonium phosphomolybdate method.
18. To determine the percentage of oxalate ion from sodium oxalate by volumetric method.
19. To determine the percentage purity of Sodium chloride in commercial salt sample by Volhard's method.

References Books

1. .A Text book of Micro and Semi micro Qualitative Inorganic Analysis- IV Edn, A. I. Vogel
2. A Text book of Quantitative Inorganic Analysis- A. I. Vogel
3. Practical Inorganic Chemistry- Pass Geoffrey and Haydn Sutcliffe

4. Advanced Practical Inorganic Chemistry- Gurudeep Raj

5. Vogel's Qualitative Inorganic Analysis- VII Edn. Orient Longman Ltd. D. Svehla

6. A Text book of Micro and Semi micro Qualitative Inorganic Analysis- IVedn, A. I. Vogel

7. A Text book of Quantitative Inorganic Analysis- A. I. Vogel

8. Practical Inorganic Chemistry- Pass Geoffrey and Haydn Sutcliffe

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : I

Course Name: Organic Chemistry Laboratory Course **Course Code:CHLC-505**

Course type : DSC-6 **4 Hrs/ Week**

Total contact hours :60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning Outcome :

On completion of this course, the students will be able:

List of experiments

1 **Qualitative Organic Analysis** **Marks: 25**

Separation, purification and identification of binary (**Solid-Solid**) mixtures.
The separation should be carried out using Chemical method.
The two components are solid-solid mixtures.
Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.
Note: Analysis of at least five mixtures should be carried out.

2 **Single Stage Preparations** **Marks: 15**

i) *p*-nitro acetanilide from acetanilide.
ii) Dibenzylidene acetone from Benzaldehyde
Note: i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material.
ii) The yield, melting point and TLC of the recrystalised product should be recorded.
Note: Student will not be allowed for practical examination if his/her record book is not completed and certified.

3 **Record Book & Viva** **Marks: 10**

Scheme of Marking:

1. Qualitative Organic Analysis (Analysis of one Component is Compulsory)

Marks	
i)Type of the mixture	07
ii) Preliminary test	02
Analysis of the individual components:	
iii). Detection of Elements	03
iv) Detection of functional groups	03
v) Determination of MP/BP	04
vi) Preparation of the derivative	04
vii) Identification (Spotting)	02
2. Preparation	
i) Brief experimental procedure along with mechanism and calculations	05
ii) Submission of recrystallized product	05
iii) Yield and MP of pure product	05

Course outcomes

To demonstrate/apply the techniques involved in organic binary mixture separation.

Semester: I

Course Name: Physical Chemistry Laboratory Course | **Course Code:CHLC-506**

Course Type: DSC-7 | **4 Hrs/ Week**

Total contact hours :60 Hrs **Lab. Work Credit:** 2 | **Marks: 50**

Learning Outcome :

On completion of this course, the students will be able:

1. To analyse sample by various instrumental techniques
2. To handling of electronic equipment
3. To understand laboratory skills, precaution, accuracy and precision.
4. To design experimental procedure for analysis important chemicals &samples
5. To understand the physical properties of chemicals
6. To distinguish accuracy of results in instrumental and non instrumental methods

---

Unit-I: Instrumental

1. Determination of strengths of halides in a mixture potentiometrically.
2. Determination of the strength of strong and weak acid in a given mixture conductometrically.
3. Determination of solubility and solubility product of sparingly soluble salt BaSO4.
4. Determine the pK_1 and pK_2 value of phosphoric acid by pH me try.
5. Determine the indicator constant of given indicator by colorimetric measurements.
6. Study of kinetics of inversion of cane sugar.
7. Interpeatition of given XRD pattern of metal/metal oxides & their indexing as a BCC &FCC. Calculation of lattice parameters & particle sizes.
8. Study of thermal decomposition patterns of metal/metal oxide systems to investigate types of desorbed water molecules and phase transition.
9. To study the glass transition temperature of any five polymers and interpretations including thermodynamic parameters.

Unit-II: **Non-Instrumental**

1. Determine the molecular refraction of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction of CH_2, C, H and O atoms.
2. To study the effect of surfactants (sodium chloride) on surface tension of given liquid.
3. To determine the radius of molecule by viscosity measurements.
4. Determine the solubility of benzoic acid in water at different temperature and hence its heat of solution.
5. Determine the formula of the complex formed between Cu(II) and ammonia by distribution method.
6. Determine the velocity constant of hydrolysis of ester.

Reference Books:

1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
2. Experiments in chemistry – D.V. Jahagirdar

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : I

Course Name: Analytical Chemistry - II **Course Code: CHTE-507**

Course type : DSE-1 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning objectives :

1. To be able to define the differents regions of an electromagnetic radiation.
2. To understand the interaction/transition of the matter with different region of electromagnetic radiation.
3. To be able to define basic elements of spectroscopic technique.
4. To be able to calculate the wavelength at which a molecule show maximum absorption of UV-visible radiation.
5. To interpret the ultraviolet-visible spectrum
6. To be able to define the bands in the IR spectrum due to fundamental frequency, and overtones, combination bands and Fermi resonance
7. To be able to define the vibrational frquency of a particular bond
8. To be able to calculate the vibrational frquency of a particular bond
9. To interpret the infrared spectrum
10. To be able to predict the structure using UV-visible and IR spectrum.

Unit-I : General introduction of spectral methods of analysis. **10Hrs**

Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter - absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, basic elements of practical spectroscopy, Resolving power, Signal to noise ratio. Uncertainty relation and natural line width, Natural line broadening, Intensity of spectral lines, Energy levels, Selection rules, Components of spectrometer and their functions.

Unit-II : Ultraviolet- Visible Spectroscopy **10Hrs**

Elementary ideas (Recapitulation), Instrumentation, Presentation of spectra, Effect of solvent on electronic transitions, The effect of conjugation, Woodward-Fieser rules for dienes, enones, aldehydess, acids, esters and aromatic compounds, Model compound studies, Visible spectra : color in compounds, Interpretation of an ultraviolet spectrum, Numericals

Unit-III : : Infrared Spectroscopy **10Hrs**

Elementary ideas (Recapitulation), Characteristic vibrational frequencies : hydrocarbons, aromatic rings, Alcohol, Phenols, Ethers, Carbonyl compounds, Amines, Nitriles, Isocyanates, Imines, Nitro compounds, Carboxylate salts, Amine salts, Amino acids, Sulfur compounds, Phosphorus compounds, Alkyl halides, Arylhalides, and metal-ligand complexes. Factors affecting IR group frequencies, overtones, combination bands and Fermi resonance. Applications of IR. Problems based on

combined applications of UV and IR spectroscopy.

References Books

1. Analytical Chemistry 6th Edition., Gary D. Christian
2. Fundamental of Analytical Chemistry 8th Edn. Skoog, West Hollar, Couch
3. ChemicalSeparations and Measurements, D.G. Peters, J.M. Hayes and G.M. Hieftie
4. Instrumental Method of ChemicalAnalysis, G.R. Chatwal& S. K. Anand
5. Introduction to instrumental analysis – Robert D. Braun
6. Inrumentalmethods of analysis – Willard, Merritt, Dean, Settle
7. Principle of instrumental analysisSkoog, Holler, Nieman
8. Introduction to spectroscopy – Pavia, Lampman, Kriz, Vyvyan
9. Spectroscopicmethods in organicchemistry – Dudley Williams, Ian Fleming
10. Spectrometric identification of organiccompounds – Robert M. Silverstein, Francis X. Webster
11. Organic structure analysis – Phillip Crews, Jaime Rodriguez, Marcel Jaspars
12. Spectroscopy of organiccompounds – P. S. Kalsi

Course Outcome: At the end of this course, students will-

1. defined the different regions of an electromagnetic radiation.
2. understood the interaction/transition of the matter with different region of electromagnetic radiation.
3. defined basic elements of spectroscopic technique.
4. calculate the wavelength at which a molecule show maximum absorption of UV-visible radiation.
5. interpret the ultraviolet-visible spectrum
6. defined the bands in the IR spectrum due to fundamental frequency, and overtones, combination bands and Fermi resonance
7. defined the vibrational frquency of a particular bond
8. calculate the vibrational frquency of a particular bond
9. interpret the infrared spectrum
10. predict the structure using UV-visible and IR data/spectrum.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

-Semester : I

Course Name: Inorganic Chemistry - I **Course Code:** CHTE -508

Course type : DSE-2 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. To understand the stability constant of metal complex, stepwise and overall formation constant.
2. To describe the factors affecting for stability of metal complexes.
3. To identify and describe techniques for determination of formation constant of metal complexes.
4. To analyse the structural and stereoisomerism of metal complexes and their classifications.
5. To understand the mechanism in metal complexes.
6. To understand acid and base hydrolysis of metal complex and their mechanism.
7. To understand the role of trans effect in the synthesis of platinum complex.
8. To distinguish between the inner and outer sphere mechanism of electron transfer reaction of metal complexes.
9. To memorise the function of essential and trace elements in biological systems.
10. To describe the structure and function of metalloporphyrins, Hemoglobin, cytochrome and hemocyanine.
11. To understand the electron transfer, respiration and photosynthesis of biological system.
12. To know the diseases caused by deficiencies of Fe, Zn, Cu and Mn ions in biological system and remedies to them.

Unit-I : Metal ligand equilibria in coordination compounds **10Hrs**

Definition of stability constant of metal complex , Step wise and overall formation constant, Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Determination of formation constant for binary complexes using pH-metric technique. Isomerism in coordination compound, Types of isomerism.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Unit-II : Reaction mechanism of transition metal complexes **10Hrs**

Ligand substitution reaction and their mechanisms of octahedral complexes. Acid hydrolysis, factors affecting the acid hydrolysis. Base hydrolysis, conjugate base mechanism. Trans effect in platinum complex, Theories of trans effect, reaction on platinum complex based on trans effect, Electron transfer reaction: mechanism of inner and outer sphere electron transfer reactions in octahedral complexes.

Unit-III :Inorganic chemistry in biological systems **10Hrs**

Essential and trace elements in biological systems and their functions, structure and function of metalloporphyrins, Hemoglobin, cytochrome and hemocyanine. Electron transfer, Respiration and photosynthesis reaction, Metal ion deficiency diseases of Fe, Zn, Cu and Mn and their therapy.

References Books

1. Principles of Inorganic chemistry- B.R. Puri, L. R. Shrma , K. C. Kalia
2. Concise Inorganic Chemistry- J.D. Lee.
3. Inorganic Chemistry- J.E. Huhey and Keiter R. L
4. Inorganic Chemistry - Gary L. Miessler, Paul J. Fischer, Donald A. Tarr ; 5thEdn
5. Mechanism of Inorganic Reaction- Fred Basolo and R.G. Pearsons.
6. Selected Topic in Inorganic Chemistry- Wahid U. Malik, G.D. Tuli and R. D. Madan.
7. Advanced Inorganic Chemistry- F. A . Cotton and Wilkinson.
8. Advanced Inorganic Chemistry- Satyaprakash, G.D. Tuli, S.K. Basu and R.D. Madan.
9. Advanced Inorganic Chemistry- Volume I and II Gurdeep Raj.
10. A Textbook of bioinorganic chemistry- A. K. Das

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : I

Course Name: Stereochemistry **Course Code:CHTE-509**

Course type : DSE-3

Total contact hours : 30 hrs **Theory Credit:** 2 **Marks** : 50

Course Objectives

Student will be able to

1 Understand the concept of Stereochemistry

2 Know the stereochemical notations

3 Know the difference between stereospecific and stereoselective reactions

4 Study the stereochemistry of some Chiral molecules like Biphenyls, allenes and Spiranes.

5 Acquire the knowledge of various methods of resolution

6 Understand stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous

7 Know about enantiomeric and diastereomeric excess

Unit-I :Introduction to Stereochemistry **10L**

Introduction and Significance of stereochemistry, Terminologies: Optical activity, Asymmetric atom, Stereogenic centre or Stereocentre, Conformation, Configuration, types of isomers, Essential criteria for a molecule to be chiral. Elements of symmetry: (A) Axis of symmetry (B) Plane of symmetry (C) Centre of symmetry, Problems based on elements of symmetry.R/S configuration and sequence rule, E/Z configuration. R/S Nomenclature in Fischer projection, Conversion of Fisher projection to Wedge and Newmann, Enantiomers, Properties of enantiomer, Diastereoisomers, Meso Compounds. Problems based on the above concepts.

Unit-II : Stereochemistry-I **10L**

Molecules with more than one chiral center, Epimers, Anomers, Threo and Erythro isomers, Prochiral relationships, stereospecific and stereoselectivereactions. Optical activity in the absence of chiral carbon in (i) biphenyls, (ii) allenes (iii) spiranes and Essential criteria for chirality, Problems based on these molecules. **Methods of resolution:**Resolution through

the formation of diastereomers, Resolution of racemic acids, bases and alcohols.Stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous.

Unit-III : Conformational Analysis **10L**

Conformational analysis of cycloalkanes, Mono- and di-substituted cyclohexanes, decalins, effect of conformation on reactivity, Conformation in six membered rings containing hetero atoms, Specific Rotation, Enantiomeric Excess, Diastereomeric excess, Topocity, Homotopic, Homotopic ligands and Faces, Enantiotopic ligand and faces, Diastereotopic ligands and faces, Problems based on these concepts

Course Outcome :

After completion of the course, students will be able to

1 Explore the concept of stereochemistry

2 Know the configuration of molecules with one, two or more chiral centers

3 Explain the conformational analysis of cyclic molecules, cyclohexane and substituted cyclohexanes

4 Know the geometry various molecules like Biphenyls, allenes and Spiranes

5 Compare stereoselective and stereospecific reactions

6 Know about the determination of enantiomeric and diastereomeric excess

Reference Books

1 Stereochemistry of Carbon Compounds: E. L. Eliel

2 Stereochemistry of Organic Compounds: D. Nashipuri

3 Organic Chemistry (Second edition): J. Clayden, N. Greeves, S. Warren

4 Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester: I

Course Name: Physical Chemistry-II **Course Code:CHTE-510**

Course Type: DSE-4 **2 Hrs/ Week**

Total Contact Hours: 30 **Theory Credit:** 2 **Marks : 50**

Course Objectives:

1. To understand the concept of ionic equilibria, dissociation constant, buffer solution and solubility products.
2. To calculate dissociation constant, pH, pOH, pKa, pKb of acidic and basic solutions.
3. To understand the theories of electrolytes, electrocapillary phenomenon and its properties.
4. To understand the concept of surface tension of liquid and curved surfaces.

Unit-I: **Ionic Equilibria and Biological Reactions** **10 Hrs**

Exact treatment of the dissociation of week acids and bases, Dissociation constant of polyprotic acids, Statistical effects in polyprotic acids, Dissociation constant of complex ions, Logarithmic expression for pH and pOH, Calculations involving buffer solution, buffer capacity and buffer index, Salt effect and solubility product and its applications.

Thermodynamics of biochemical reactions, Binding of oxygen by myoglobin and haemoglobin, Reaction between microscopic and macroscopic dissociation constant.

Unit-II: **Electrochemistry** **10 Hrs**

Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation Testing of the equation, Debye-Falkenhagen effect, Wein effect, activity coefficient, mean ionic activity coefficient; Debye-Huckel limiting law ionic strength.

Electrocapillary phenomena, and its measurements. Effect of anions, cations and molecules on electrocapillary curves. Electrocapillary properties of mercury-solution interface.

Polarography: theIlkovic equation and its derivation, concentration polarization, Instrumentation, advantages of DME, half wave potential. Applications of polarography, numerical.

Unit-III: **Surface Chemistry** **10 Hrs**

Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, numericals.

Reference Books:

1. Chemical Kinetics - Laidler (McGraw-Hill)

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

2. Kinetic and Mechanism of Chemical Transformations - J. Rajaram and J.C. CURIACOSE (Macmillan India Ltd.)
3. Physical Chemistry - Atkins (Oxford)
4. Thermodynamics for Chemists - S. Glasstone (EWP, New Delhi)
5. Physical Chemistry - G. M. Barrow
6. Advanced Physical Chemistry - Gurdeep-Raj (Pelenum)
7. Micelles : Theoretical and Applied Aspects - V. Moroi (Plenum)
8. Text Book of Physical Chemistry - S.Glasstone (McMillan)
9. Physical chemistry – Robert A .Alberty ., Robert J .Silbey
10. Statistical Thermodynamic – M. C. Gupta

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : I

Course Name: Research methodology **Course Code:** CHRM-511

Course type :- --- **4 Hrs/ Week**
Total contact hours :60 Hrs **Theory Credit:** 4 **Marks** :100

Learning outcomes:

On completion of this course, the students will be able:

1. Knowledge of basic concepts of research methodology
2. Current trends in chemical research.
3. Acquiring the fundamental knowledge of various characterization techniques.
4. Applications of characterization techniques viz.; XRD, SEM, TEM, UV, IR, NMR and Mass spectrometry in research

---

Unit-I : Unit-I :Literature Survey **10Hrs**

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital:Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers

Unit-II :Search Engines **10Hrs**

Scirus, Google Scholar, Wiki- Databases, Chem Spider, Science Direct, Pub Med, Sci Finder, Mendeley, Scopus, Web of Science. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information

Unit-III : Methods of Scientific Research and Writing Scientific Papers **10Hrs**

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

Unit-IV : Chemical Safety and Ethical Handling of Chemicals: **10Hrs**

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that

pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit-V : Data Analysis **10Hrs**

The Investigative Approach: Making and Recording Measurements. SI Units and their uses, Scientific method and design of experiments, Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of the multiple linear regression analysis.

Unit-VI : Fundamentals of Computers and Application **10Hrs**

a. Introduction to basic software

i. MS Word, ii. Power Point, iii. Excel, b. Introduction to Chemistry related software i. Gaussian, ii. Gaussview, iii. ChemDraw / Chem Sketch

References Books

1. Practical Skills in Chemistry, J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, Pearson Education Ltd. [Prentice Hall] (2002)
2. Research Methodology. Methods and Techniques: C. R. Kothari.
3. Research Methodology: Tools and Techniques by Dr. Prabhat Pandey, Dr.Meenu Mishra Pandey

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

M.Sc. First Year Semester-II Course Structure

Course type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned			Marks		
			Theory	Practical	Theory	Practical	Total Credits	Conti. Inter. Assmen.	End. Sem Exam	Total Marks
Major Mandatory DSC	CHTC-550	DSC-8 Mol.Spectro.	2	-	2	-	8T	20	30	50
	CHTC-551	DSC-9 Inorg. Chem	2	-	2	-		20	30	50
	CHTC-552	DSC-10 Org. Chem	2	-	2	-		20	30	50
	CHTC-553	DSC-11 Phy. Chem	2	-	2	-		20	30	50
	CHLC-554	DSC-12 Inorg. Chem. Lab course	-	4	-	2	6L	20	30	50
	CHLC-555	DSC-13 Org. Chem. Lab course	-	4	-	2		20	30	50
	CHLC-556	DSC-14 Phy. Chem. Lab course	-	4	-	2		20	30	50
DSE (Choose one from your specialization and any one from remaining three)	CHTE -557	DSE-5 Anal. Chem	2	-	2	-	4T	20	30	50
	CHTE -558	DSE -6 Inorg. Chem	2	-	2	-		20	30	50
	CHTE -559	DSE -7 Org. Chem	2	-	2	-		20	30	50
	CHTE -560	DSE -8 Phy.Chem	2	-	2	-		20	30	50
OJT/FP (Chose any one)	CHOJT-561	On the Job Training	-	8	-	4	4L	40	60	100
	CHFP-562	Field Project	-		-			40	60	100
Total			**12**	**20**	**12**	**06**	**22**	**220**	**330**	**550**

Course code Nomenclature :

DSC-Discipline Specific Core ,**DSE**- Discipline Specific Elective, **T**-Theory, **L**- Laboratory course, **CHTC**- Chemistry Theory Core , **CHLC**- Chemistry Laboratory Core , **CHTE**- Chemistry Theory Elective , **CHOJT**- Chemistry On the Job Training, **CHFP**- Chemistry Field Project

-

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,

M. Sc. First Year Semester- II : Course code, Course Name Teaching Hrs, Credit assigned CIA & ESE & Total marks

Sr. No.	Course Code	Course Name	Teaching (Hr/W)	Credits Assigned	Conti.Inter.Assmen.	End. Sem Exam	Total Marks
Course type : DSC-Major Mandatory							
1.	CHTC-550	Molecular Spectroscopy	2	2	20	30	50
2.	CHTC-551	Electronic spectroscopy of transition metal complexes	2	2	20	30	50
3.	CHTC-552	Organic Chemistry - II	2	2	20	30	50
4.	CHTC-553	Quantum Chemistry	2	2	20	30	50
5.	CHLC-554	Inorganic Chemistry Laboratory Course	4	2	20	30	50
6.	CHLC-555	Organic Chemistry Laboratory Course	4	2	20	30	50
7.	CHLC-556	Physical Chemistry Laboratory Course	4	2	20	30	50
Course type : DSE-**(Choose one from your specialization and any one from remaining three)**							
8.	CHTE -557	Analytical Chemistry - III	2	2	20	30	50
9.	CHTE -558	Inorganic Chemistry - II	2	2	20	30	50
10.	CHTE -559	Aromatic Substitutions and Molecular Rearrangements	2	2	20	30	50
11.	CHTE -560	Physical Chemistry-III	2	2	20	30	50
Course type :OJT/FP (Chose any one)							
12.	CHOJT-561	On the Job Training	8	4	40	60	100
13.	CHFP-562	Field Project	8	4	40	60	100
14.		**Total**	**32**	**22**	**220**	**330**	**550**

Course code Nomenclature :

DSC-Discipline Specific Core ,**DSE**- Discipline Specific Elective, **T**-Theory, **L**- Laboratory course, **CHTC**- Chemistry Theory Core , **CHLC**- Chemistry Laboratory Core , **CHTE**- Chemistry Theory Elective , **CHOJT**- Chemistry On the Job Training, **CHFP**- Chemistry Field Project

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : II

Course Name: Molecular Spectroscopy **Course Code: CHTC-550**

Course type : DSC-8 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning objectives :

An introduction to molecular spectroscopy is a fundamental part in chemistry that explores how molecules interact with electromagnetic radiation, leading to the absorption, emission, and scattering of light. The learning objectives of an introductory course in molecular spectroscopy typically include:

1. Understanding Electromagnetic Radiation: Explain the nature of electromagnetic radiation, including the properties of waves and particles, wavelength, frequency, and energy relationships.

2. Types of Spectroscopy: Introduce various spectroscopic techniques, such as rotational/microwave, Infrared (IR)/vibrational, and Raman spectroscopy, and their applications in the study of molecules.

3. Interaction of Light with Matter: Describe how molecules interact with electromagnetic radiation by absorbing or emitting photons and how these interactions are related to energy levels in molecules.

5. Vibrational Spectroscopy (IR): Explain how IR spectroscopy is used to study molecular vibrations, including stretching and bending modes, and how it can be applied to identify functional groups in organic compounds.

6. Rotational Spectroscopy (Microwave): Introduce microwave spectroscopy and its application in studying the rotational motion of diatomic and polyatomic molecules.

7. Raman Spectroscopy: Introduce Raman spectroscopy and how it is used to study molecular vibrations and rotations, with a focus on its complementary information to IR spectroscopy.

Unit-I : Microwave spectroscopy: **10Hrs**

Rotation of molecules, rotational spectra, diatomic molecules - rigid diatomic molecules, intensities of spectral lines, effect of isotopic substitution, non-rigid rotator, the spectrum of non-rigid rotator, polyatomic molecules, technique and instrumentation in outline, applications, numerical problems.

Unit-II : Vibrational Spectroscopy: **10Hrs**

Review of linear harmonic oscillator, the vibrating diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator, the vibration-rotation spectrum of carbon monoxide, breakdown of the Born-Oppenheimur approximation, the vibration of polyatomic molecules,

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,

overtones and combination frequencies, the influence of rotation on the spectra of polyatomic molecules, the influence of nuclear spin, symmetric top molecules, analysis by Infra-red technique - Group frequencies, outline of technique and instrumentation, numerical problems.

Unit-III : : Raman spectroscopy: **10Hrs**

Classical and quantum of theory of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, rule of mutual exclusion, overtone and combination vibrations, Rotational fine structure, outline of technique and instrumentation, applications, numerical problems.

References Books

1. The Determination of Molecular Structure : P. J. Wheatley
2. Physical Chemistry : G. M. Barrow
3. Instrumental Methods of Chem. Analy. Chatwal and Anand.
4. A Text book of Phy.Chem. : A.S. Negi& S. C. Anand
5. Instrumental Methods of Chemical Analysis - Willard, Merritt, Dean &Seatle
6. Instrumental Methods of Chemical Analysis - Chatwal, Anand
7. Instrumental Methods of Chemical Analysis - B.K. Sharma
8. Instrumental Methods of Chemical Analysis -R.D. Braun
9. Analytical Chemistry : Skoog and West
10. Principles of Instrumental Analysis: Skoog and West.
11. Fundamentals of Molecular Spectroscopy: Banwell.
12. Atomic and Molecular Structure : ManasChanda

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : II

Course Name: Electronic spectroscopy of transition metal complexes **Course Code:CHTC-551**

Course type : DSC-9 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

10. To describe the generation of spectroscopic term symbols , ground state term & total term symbols, significance of spin multiplicities.
1. To use of microstates for representation electron representations
2. To sketch term energy level diagram.
3. To understand the designation of spin multiplicities to ligand field excited states of high and low spin complex.
4. To interpret A,E, T symmetric label for electronic configurations.
5. To construct correlation diagram of various electronic configurations
6. To analyse and interpretation Orgel diagram and Tanabe Sugano diagram.
7. To interpret electronic spectra of transition metal complexes.
8. To calculate the D_q, B and β parameters of complex.
9. To understand the Lewis and Bronsted Concept of Acids and Bases.
10. To apply knowledge of VBT concept for prediction structure of molecules .

Unit-I : Spectroscopic term symbols and ligand field excited states **10Hrs**

Spectroscopic terms symbols, Inter-electronics repulsion, Spin-orbit coupling, Ground state term, Microstates and its use, Rules for determination of total terms symbol of d^1 to d^5configurations. Energy ordering of terms and their energy level diagram, Weak and stronger field approach, Calculation and labelling of spin multiplicities to ligand field excited states of low spin complex. Designation of A, E, T symmetric label to electronic configuration, Correlation diagram of d^1, d^2, d^8 and d^9 configuration in octahedral and tetrahedral environments, Non-crossing rule.

Unit-II : Interpretation of electronic spectra of metal complexes **10Hrs**

Orgel diagram of d^1 to d^9 configuration/ metal complex in an octahedral

and tetrahedral environments, Selection rule for electronic transitions, Tanabe Sugano diagram of d^2 and d^3 configurations. Measurement of the absorption spectra, Charge transfer transitions, Types of charge transfer transitions, Examples of charge transfer spectra, Band intensities, Intensity of d-d and change transfer bands. Interpretation of electronic spectra of transition metal complex, Konig's method for calculation of D_q, B and β parameters and numericals.

Unit-III: Lewis and Bronsted Concept of Acids and Bases and Geometry of molecules **10Hrs**

Lewis and Bronsted Concept of Acids and Bases, examples of Lewis acid - Lewis base complex formation, Strong and weak acid, strength of acid factors affecting acid strength. Donor acceptor chemistry of NH_3: BF_3, BF_3 : $O(C_2H_5)_2$, Br_2 : CH_3OH adducts, HOMO -LUMO energy. Application of valence bond theory to identify structure of : H_2SO_4, K_2CO_3, .HNO_3, NH_4Cl, $NaBH_4$, $AlCl_3$, $LiAlH_4$, $SiCl_4$, $SnCl_2$, $SnCl_4$, H_3PO_2, H_3PO_3, H_3PO_4, $HClO_4$, K_2CrO_4, $K_2Cr_2O_7$ and $KMnO_4$

References Books

1. Inorganic electronic spectroscopy - A.B.P. Lever.
2. Concise Inorganic Chemistry - J. D. Lee.
3. Principles of Inorganic chemistry, B.R. Puri, L. R. Shrma , K. C. Kalia
4. Symmetry and Spectroscopy of Molecules - K. Veera Reddy
5. Symmetry and Group theory in Chemistry , R Ameta
6. Inorganic Chemistry - G.Y.Miessler and D.A. Tarr
7. Inorganic Chemistry – Shriver & Atkins
8. Principle of Inorganic chemistry- Brian W. Pfennig .

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : II

Course Name: Organic Chemistry - II **Course Code:CHTC-552**
Course type : DSC-10 **2 Hrs/ Week**
Total contact hours : 30hr **Theory Credit:** 2 **Marks** : 50

Course Objectives

Student will be able to

1 Understand various reactions involved in addition to C-C and C-O double bond
2 Acquire the stereochemical aspects in addition reaction
3 Demonstrate/apply the concepts involved in elimination reaction
4 Understand mechanism of various named reactions

Unit-I :Addition to Carbon –Carbon multiple bond 10 Hrs

Mechanism and stereochemical aspect of addition reactioninvolving electrophile, nucleophile and free radicals. Regioselectivity and chemoselectivity, orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.

Unit-II :Addition to Carbon–HeteroMultiplebond 10 Hrs

Mechanismofmetalhydridereductionofsaturatedandunsaturatedcarbonylcompounds,acid, ester and nitriles. Addition of Grignard reagent, Organo zinc and organo lithium reagent to carbonyl and unsaturated carbonyl compounds. Wittig reaction.
Mechanism of condensation reaction involving enolates, Aldol, Knovenagel, Claisen, Mannich,Benzoin, Perkin, Stobbe reaction. Hydrolysis of esters.

Unit-III : Elimination Reactions: 10 Hrs

The E_1, E_2, and E_1CB mechanism, orientation of double bond. Reactivity: effect of substrate structure, attacking base, the leaving group and the medium, Hoffmann elimination, Saytzeff elimination, Chugaev elimination, pyrolytic syn elimination, Elimination vs Substitution

References Books

1 Advanced Organic Chemistry, IV Edition: J. March
2 Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.
3 A Guide Book to Mechanism in Organic Chemistry: Peter Sykes
4 Synthetic Organic Chemistry: H. O. House
5 Principles of Organic Synthesis: R. O. C. Norman
6 Organic Chemistry: Clayden, Greeves and Warren
7 Mechanism and Structure in Organic Chemistry: E. S. Gould

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester: II

Course Name: Quantum Chemistry **Course Code: CHTC-553**

Course Type: DSC-11 **2 Hrs/ Week**

Total Contact Hours: 30 **Theory Credit:** 2 **Marks** : 50

Course Objectives:

1. To understand the fundamental principles of quantum mechanics.
2. To solve the Schrodinger equations calculate wave function and energy levels.
3. To understand the postulates of quantum mechanics.
4. To understand the Huckel Molecular Theory of conjugated system and its applications.

Unit-I: **I** 10 Hrs

The Schrodinger's equation for particle waves, Wave function ψ and its physical meaning, Wave particle duality, Uncertainty principle, The wave function ψ and its physical meaning, Eigen value and eigen functions.
Postulates of quantum mechanics, Operators, Hermitian, Linear and Hamiltonian, Condition of Normalization, particle in one dimensional box particle in three dimensional box, .numericals.
Theory of Angular Momentum: Angular Momentum Operators, Ladder Operators,

Unit-II: **Quantum Chemistry II** 10 Hrs

Unit-II :- Harmonic Oscillator, particle on a sphere, Schrodinger's equation for spherical coordinates rigid rotator, Variation theorem, The method of perturbation (Theory) and Applications to two electron systems, Term symbols and selection rules spin orbit coupling.

Unit-III: **Molecular Orbital Theory** 10 Hrs

Huckel's Molecular Orbital theory of conjugated systems, Application to ethylene, butadiene, cyclopropenyl, and cyclobutadiene, Electron densities, Bond Order, Free valence indices.

Reference Books:

1. Quantum Chemistry : Ira N. Levine
2. Quantum Chemistry : R.K. Prasad
3. Quantum Chemistry : B.K. Sen
4. Principles of Physical Chemistry : Puri, Sharma, Pathania
5. Advanced Physical Chemistry: Gurdeep - Raj, Plenum.
6. Physical Chemistry : Maron and Prutton

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester : II

Course Name: Inorganic Chemistry Laboratory Course **Course Code:CHLC-554**

Course type : DSC-12 **4 Hrs/ Week**

Total contact hours :60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. To design experimental procedure for synthesis of metal complexes , calculation of conversion factors and characterization of synthesized coordination complexes compounds.
2. To understand, which skills are required in chemical laboratory .
3. To understand importance of accuracy and precision in chemical analysis
4. To design the experimental procedure for separation and estimation of metals from mixture solution
5. To estimate the amount of constituents of chemicals by volumetric and gravimetric methods.
6. To apply grasped knowledge for finding purity of chemicals.

List of experiments

Group- I (Any 3)

1. Preparation of $[Mn(acac)_3]$ complex and its spectral analysis .
2. Preparation of $Hg[(Co(SCN)_4]$ complex and its spectral analysis.
3. Preparation of $[Co(III)(NH_3)_6]Cl_3$ complexes and its spectral analysis.
4. Preparation of $[Ni(NH_3)_6]Cl_2$ complex and its spectral analysis.

Group- II (Any 2)

5. Preparation of Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$ complex and its thermogravimetric analysis.
6. Preparation of $VO(acac)_2$ complex and its thermogravimetric analysis.
7. Preparation of $[Cu(NH_3)_4]SO_4.H_2O$ complex and its thermogravimetric analysis .

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Group- III (Any 3)

8. Preparation of $K_3[Fe(C_2O_4)_3]$ complex and estimate the amount Iron present in it.

9. Preparation of $[Co(III)(NO_2)(NH_3)_5]Cl_2$ complex and estimate the amount cobalt present in it.

10. Preparation and estimation of percentage of copper from the $[Cu(NH_2CSNH_2)_5](NO_3)_2$ complexes

Group- IV (Any 3)

11. Separation of Copper and Nickel from the given binary mixture sample and estimate the amount of Copper by volumetric and Nickel by gravimetric method.

12. Separation of Nickel & Zinc from given binary mixture sample and estimate the amount of Zinc by volumetric method and Nickel by gravimetric method.

13. Separation of Copper & Barium from given binary mixture sample and estimate the amount of Copper by volumetric method and Barium by gravimetric method.

14. Separation of Iron & Aluminium from given binary mixture sample and estimate the amount of Aluminium by volumetric method and Iron by gravimetric method .

15. Separation of Copper & Iron from given binary mixture sample and estimation of amount of Copper by volumetric method and Iron by gravimetric method.

16. Separation of Iron &Magnesium from given binary mixture sample and estimation of amount of Iron & Magnesium volumetric method .

Group- V (Any 3)

17. Determination of percentage purity of concentrated hydrochloric acid by volumetric method.

18. Determination of chemical oxygen demand from given sample of water by volumetric method.

19. Determination of dissolved oxygen from given sample of water by volumetric method .

20. Determination of the percentage purity of copper sulphate from given commercial sample.

21. Determination of the amount of water content in commercial sample of copper sulphate .

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,

References Books

1. Advanced Practical Inorganic Chemistry- GurudeepRaj;.
2. Practical Inorganic Chemistry- Pass Geoffrey and Haydn Sutcliffe.
3. A Text book of Micro and Semi micro Qualitative Inorganic Analysis, IVedn, A. I. Vogel
4. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
5. Vogel's Qualitative Inorganic Analysis, VII Edn. Orient Longman Ltd. D. Svehla

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Semester : II

Course Name: Organic Chemistry Laboratory Course **Course Code:CHLC-555**

Course type : DSC-13 **4 Hrs/ Week**

Total contact hours :60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning Outcome :

On completion of this course, the students will be able:

List of experiments

1 **. Qualitative Organic Analysis:** **Marks: 25**

Separation, purification and identification of binary (**Solid-Liquid**) mixtures.
The separation should be carried out using Chemical method.
The two components are solid-liquid mixtures.
Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.
Note: Analysis of at least five mixtures should be carried out.

2 **Single Stage Preparations:** **Marks: 15**

i) *p*-Bromo acetanilide from acetanilide.
ii) 1,4-dichlorobenzene from p-chloroaniline
iii) Benzophenone from benzene (Friedal Craft)
Note: i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material.
ii) The yield, melting point and TLC of the recrystallized product should be recorded.
Note: Student will not be allowed for practical examination if his/her record book is not completed and certified.

3 **Record Book & Viva** **Marks: 10**

Scheme of Marking:

1. Qualitative Organic Analysis (Analysis of one Component is Compulsory)

	Marks
i)Type of the mixture	07
ii) Preliminary test	02
Analysis of the individual components:	
iii) Detection of Elements	03
iv) Detection of functional groups	03
v) Determination of MP/BP	04
vi) Preparation of the derivative	04
vii) Identification (Spotting)	02

2. Preparation

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

i) Brief Experimental procedure along with mechanism and calculations	05
ii) Submission of recrystallized product	05
iii) Yield and MP of pure product	05

Course Outcomes

1. To Perform/demonstrate the techniques involved in organic binary mixture separation specially solid- liquid mixture.
2. To perform distillation techniques for purification of organic compounds.
3. To use/ apply the technique of separation, crystallization derivatization and function Group detection.
4. To use the methods for the preparation of useful compounds using named reaction

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester: II

Course Name: Physical Chemistry Laboratory Course
Course Code: CHLC-556
Course Type: DSC-14
4 Hrs/ Week
Total contact Hours :60 Hrs **Lab. Work Credit:** 2
Marks: 50

Learning Outcome :

On completion of this course, the students will be able:

1. To analyse sample by various instrumental techniques
2. To handling of electronic equipment
3. To understand laboratory skills, precaution, accuracy and precision.
4. To design experimental procedure for analysis important chemicals &samples
5. To understand the physical properties of chemicals
6. To distinguish accuracy of results in instrumental and non instrumental methods

Unit-I: Instrumental

1. Determination of dissociation constants of phosphoric acid potentiometrically.
2. Determination of dissociation constants of weak acid potentiometrically.
3. Determination of acidic and basic dissociation constants of an amino acid and its isoelectric point.
4. Determination of equilibrium quotient for the formation of monothiocynato iron (III) complex.
5. To study the kinetics of mutarotation of glucose/fructose polarographically.
6. Study of thermal analysis (TG/DTA/DSC) in atmosphere of evolved gases e.g decomposition of $CaCO_3$, $KClO_3$ etc in environment of gases such as N_2, O_2, CO_2)
7. Synthesis of various crystalline modifications of a hydrous transition metal oxide and their characterization by infra – red spectroscopy.
8. Investigating esterification reaction by using solid acid catalyst and study of the reaction kinetics by IR spectroscopy.
9. Study of kinetics of zeolite synthesis by infrared spectroscopy.
10. Identification of acidic and basic sites of a catalyst by in situ infrared spectroscopy.

Unit-II: Non-Instrumental

1. To study the adsorption of acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir's isotherm.
2. To construct the phase diagram for three component system (chloroform-acetic acid water).
3. To study auto catalysis reaction between potassium permanganate and oxalic acid.
4. Determine the rate constant of the reaction between potassium persulphate and

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar

potassium iodide having equal/unequal concentration of the reacting species.

5. To study the variation of viscosity with the composition of mixtures (ethanol-water-HNO3 -chloroform) and to determine the formation of complex between two liquids.

Reference Books:

1. Systematic experimental physical chemistry – T. K. Chondhekar& S.W. Rajbhoj
2. Experiments in chemistry – D.V. Jahagirdar

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester : II

Course Name: Analytical Chemistry - III **Course Code: CHTE-557**

Course type : DSE-5 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning objectives :

1. To understand basic principle of different chromatographic Techniques for separation of constituents of mixtures
2. To understand theory, instrumentation, working procedure and application as well as limitations of TLC
3. To understand theory, instrumentation, working procedure and application as well as limitations of liquid- liquid partition chromatography
4. To understand theory, instrumentation, working procedure and application as well as limitations of column chromatography
5. To understand theory, instrumentation, working procedure and application as well as limitations of gel pearmeation chromatography
6. To understand theory, instrumentation, working procedure and application as well as limitations of ion exchange chromatography
7. To understand theory, instrumentation, working procedure and application as well as limitations of high performance liquid chromatography
8. To understand theory, instrumentation, working procedure and application as well as limitations of gas chromatography
9. To be able to select a particular chromatographic technique for separation of the constituents from a mixture.
10. To be aware of the various problems associated with different chromatographic techniques.

Unit-I : Chromatographic Techniques. **10Hrs**

Paper Chromatography: Elementary ideas (Recapitulation)

Thin layer Chromatography: Elementary ideas (Recapitulation), Introduction, Principles, Superiority of TLC over other chromatographic technique, Experimental techniques, Solvent systems, Plate development, Detection of components, Evaluation of chromatogram by different methods, Applications, Limitation. High performance thin layer chromatography

Liquid-Liquid partition chromatography: Introduction, theory, solid supports, selection of stationary and mobile phases, solvent systems, reverse phase chromatography, choice of adsorption or partition, applications of partition chromatography. Ultra performance liquid chromatography

Column Chromatography: Principle, Experimental details, Theory of development, Column efficiency, Factors affecting column efficiency, and

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar

applications. Advanced flash chromatography

Gel permeation Chromatography: Principle materials, Gel preparation, Column packing, Detectors and applications.

Ion Exchange Chromatography: Ion Exchange resins, Ion exchange equilibria, Ion exchange capacity of resins and its determination, Applications of ion exchange resins to chromatography, Ion chromatography based on suppressors

10Hrs

Unit-II : Gas Chromatography

Introduction, Branches of gas chromatography, principles of gas-liquid chromatography, instrumentation-Carrier gas, Sample introduction system, Columns, Detectors, substrates, Temperature control, Evaluation, Retention volume, Resolution, Applications, Numericals.

10Hrs

Unit-III : : High Performance Liquid Chromatography

Principle, instrumentation - Column, Column packing, Mobile phone, Pumping system, Detector system, Practical procedure, Applications, HPLC adsorption and partition chromatography

References Books

1. Analytical Chemistry 6th Edition., Gary D. Christian
2. Fundamental of Analytical Chemistry 8th Ed^{n}. Skoog, West Hollar, Crouch
3. Chemical Separations and Measurements, D.G. Peters, J.M. Hayes and G.M. Hieftie
4. Instrumental Method of Chemical Analysis, G.R. Chatwal & S. K. Anand
5. Introduction to instrumental analysis – Robert D. Braun
6. Principle of instrumental analysis – Skoog, Holler and Crouch

Course Outcome: At the end of this course, students will-

1. understood basic principle of different chromatographic Techniques for separation of constituents of mixtures
2. understood theory, instrumentation, working procedure and application as well as limitations of TLC
3. understood theory, instrumentation, working procedure and application as well as limitations of liquid- liquid partition chromatography
4. understood theory, instrumentation, working procedure and application as well as limitations of column chromatography
5. understood theory, instrumentation, working procedure and application as well as limitations of gel pearmeation chromatography
6. understood theory, instrumentation, working procedure and application as well as limitations of ion exchange chromatography

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,

7. understood theory, instrumentation, working procedure and application as well as limitations of high performance liquid chromatography
8. understood theory, instrumentation, working procedure and application as well as limitations of gas chromatography
9. select a particular chromatographic technique for separation of the constituents from a mixture.
10. awared of the various problems associated with different chromatographic techniques.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University.
Aurangabad-431004

Semester : II

Course Name: Inorganic Chemistry - II **Course Code:CHTE-558**

Course type : DSE-6 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. To define and classify metal carbonyls
2. To design procedure to synthesize mononuclear and binuclear metal carbonyl
3. To understand the properties and structure metal carbonyl .
4. To apply the concept of effective atomic number for prediction of stability of metal carbonyls.
5. To synthesize the nitrosyl halides and their properties .
6. To understand the structure and properties and application of sodium nitroprusside.
7. To apply the knowledge of EAN and 18 electron rules metal nitrosyl compound of transition elements
8. To understand the d orbital splitting in different environment .
9. To understand factor affecting crystal field splitting energy
10. To describe Jahn Teller distortion and CFSE for high and low spin complexes

Unit-I : Chemistry of Metal Carbonyls **10Hrs**

Classification of metal carbonyls, structure carbonyl group, Preparation, properties, structures and bonding of $Ni(CO)_4$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Cr(CO)_6$, $Mn_2(CO)_{10}$, $Co_2(CO)_8$, , $Mo(CO)_6$ and $W(CO)_6$, $Co_4(CO)_{12}$ and $V(CO)_6$. EAN rule applied to metal carbonyls. Application of EAN rule to of mixed metal carbonyls. Preparations and properties of metal carbonyl halides.

Unit-II : Metal nitrosyl compounds **10Hrs**

Preparations and properties of Nitrosyl Fluoride, Nitrosyl chloride, and Nitrosyl bromide. Preparation and properties of Metal nitrosyl halides containing NO^- anion and NO^+ cations, Preparation, structure and application of sodium nitroprusside. Application EAN and Eighteen electron rules to nitrosyl compounds of Cobalt, Iron and Manganese. Significance of NO for the life of living animal

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Unit-III : Crystal field theory **10Hrs**

Important feature of CFT, Crystal field splitting d orbital in octahedral , tetrahedral, square planer and tetragonal complexes, Factors affecting 10Dq, Spectrochimical series, Calculation of CFSE of high and low spin complex Jahn teller distortion , Limitation of CFT

References Books

1. Advance Inorganic chemistry- S.K. Agrawal, Keemti Lal
2. Principles of Inorganic chemistry, B.R. Puri, L. R. Shrma , K. C. Kalia
3. Concise Inorganic Chemistry - J. D. Lee.
4. Inorganic Chemistry - G.Y.Miessler and D.A. Tarr
5. Inorganic Chemistry – Shriver & Atkins
6. Principle of Inorganic chemistry- Brian W. Pfennig .
7. Advanced Inorganic Chemistry- Satyaprakash, G.D. Tuli, S.K. Basu and R.D. Madan.
8. Selected Topic in Inorganic Chemistry- Wahid U. Malik, G.D. Tuli and R. D. Madan.
9. Advanced Inorganic Chemistry- F. A . Cotton and Wilkinson.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

Semester : II

Course Name: Aromatic Substitutions and Molecular Rearrangements **Course Code: CHTE-559**

Course type : DSE-7 **2 Hrs/ Week**

Total contact hours : 30 hrs **Theory Credit:** 2 **Marks** : 50

Course Objectives :

Student will be able to

1 Understand aromatic electrophilic substitution reactions
2 Acquire the knowledge of directing nature of functional groups
3 Know directing nature of attacking electrophiles on various aromatics
4 Understand requirement for aromatic nucleophilic substitution reactions
5 Describe the basic concepts in molecular rearrangement
6 Acquire the knowledge of migratory aptitude

10 Hrs

Unit-I :Aromatic Electrophilic Substitutions

The arenium ion mechanisum, orientation and reactivity, energy profile diagram. Directing nature of various groups, Orientation of attacking electrophile on mono and di-substituted benzene, Five and six membered heterocycles, Electrophilic substitution on polycyclic aromatic hydrocarbons (Naphthalene, anthracene) The ortho/para ratio, IPSO substitution, orientation in other ring system, Recapitulation of halogenation, nitration, sulphonation and Fridel Craft's reaction (Alkylation and acylation), diazonium coupling

10 Hrs

Unit-II :Aromatic Nucleophilic Substitutions

. The SNAr, SN1, benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophile on reactivity, Chichibabin reaction (Pyridine, quinolone and isoquinoline)

10 Hrs

Unit-III : Rearrangements:

General mechanistic consideration, nature of migration, migratory aptitude, memory effect, pinacol-pinacolone, Benzil–Bezilic acid, Beckmann, Hoffman and Fries rearrangements.

References Books

1 Advanced Organic Chemistry, IV Edition: J. March
2 Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.
3 A Guide Book to Mechanism in Organic Chemistry: Peter Sykes
4 Synthetic Organic Chemistry: H. O. House
5 Principles of Organic Synthesis: R. O. C. Norman
6 Organic Chemistry: Clayden and Greeves
7 Mechanism and Structure in Organic Chemistry: E. S. Gould

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester: II

Course Name: Physical Chemistry - III **Course Code: CHTE-560**

Course Type: DSE-8 **2 Hrs/ Week**

Total Contact Hours: 30 **Theory Credit:** 2 **Marks** : 50

Course Objectives:

1. To understand the basic concepts of phase rule
2. To analyse and interpret phase diagrams for single and multicomponent systems.
3. To understand the basic concept of crystallography.
4. To understand the basic concepts of photochemistry, their different theories and possible applications.

10 Hrs

Unit-I: **Phase Rule**

Recapitulation of phase rule and terms involved in it, one component system, two component systems (solid-solid, solid-liquid and liquid-liquid), reduced phase rule, three component systems, partially miscible three liquid systems : one partially miscible pair, two partially miscible pairs, three partially miscible pairs, systems composed of two solids and a liquid : crystallization of pure components only, formation of binary compounds, formation of ternary compounds, formation of solid solutions, partial miscibility of solid phases, numericals.

10 Hrs

Unit-II: **Crystallography**

Classification of solids on the basis of shapes, and bonding, crystal lattice and unit cell, laws of crystallography crystal symmetry, symmetry elements, lattice planes and their designations, liquid crystals.

Principle of crystal structure. close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures. packing in ionic solids, atomic packing factor in crystal structures, ionic radius, radius ratio rule, (3, 4, 6, 8 coordinate structures). Octahedral and tetrahedral voids, isomorphism and polymorphism, numericals.

10 Hrs

Unit-III: **Photochemistry**

Absorption of light and nature of absorption spectra, electronic transitions. Photodisociation and pre-dissociation. photo-oxidation, photo-reduction and photo-dimerization. photo-physical phenomenon. Jablonski diagram. photo-physical pathways of molecular deexcitation, difference between delayed fluorescence and phosphorescence, Stern-Volmer equation, deviations from Stern-Volmer equation, concentration dependence of quenching and eximer formation, quenching of fluorescence formation of excimer and exciples.

Reference Books:

1. Principles of Physical Chemistry : Puri, Sharma, Pathania
2. Advanced Physical Chemistry : Gurdeep - Raj, Plenum.
3. Physical Chemistry : Maron and Prutton
4. Introduction to Molecular Photo-chemistry : C.H.J. Wells
5. Fundamentals of Photo-chemistry : Rohatgi-Mukherjee.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004

6. Photo-chemistry : J.G. Calvert & J.N. Pitts.
7. Ptoho-luminiscence of solutions : C.A. Parker.
8. Photo-chemistry : A. Singh and R. Singh
9. Atkin's Physical Chemistry : Peter Atkins
10. Solid State Chemistry : D.K. Chakraborti
11. Solid State Chemistry and its applications : A.R. West.
12. The Determination of Molecular Structure : P.J. Wheatley.
13. Solid State Chemistry : N.B. Hannary.
14. Principles of Solid State : H.V. Keer.
15. Physical Chemistry : G.K. Vemulapalli.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester : II

Course Name: On the Job Training **Course Code:**CHOJT-561

Course type :- **8 Hrs/ Week**

Total contact hours :120 Hrs **Lab. Work Credit:** 4 **Marks** :100

Learning outcomes:

On completion of this course, the students will be able:

1.

2.

3.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University
Aurangabad-431004

Semester : II

Course Name: Field Project **Course Code:CHFP-562**

Course type :- -- **8 Hrs/ Week**

Total contact hours :120 Hrs **Lab. Work Credit:** 4 **Marks** :100

Learning outcomes:

On completion of this course, the students will be able:

1.

2.

3.

4.

Professor & Head
Dept. of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004