DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

NAAC- 'A ++' Grade

CIRCULAR NO.SU/ B.Sc./NEP-2020/91/2026

It is hereby inform to all concerned that, the Revised syllabi prepared by the Board of Studies/Ad-hoc Boards/Committees and recommended by the Faculty of Science & Technology, **Academic Council at its meeting held on 02nd June 2026 has accepted** the following **Revised syllabi of Bachelor of Science & Basket** under the Faculty of Science & Technology **as per Norms of National Education Policy-2020 and as per Government Letter dated 13 March 2024** run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc.Botany	Vth and VIth semester
2.	B.Sc.Biotechnology	Vth and VIth semester
3.	B.Sc.Zoology	Vth and VIth semester
4.	B.Sc.Agrochemical and Fertilizer	Vth and VIth semester
5.	B.Sc.Geology	Vth and VIth semester
6.	B.Sc.Environmental Science	Vth and VIth semester
7.	B.Sc.Home Science	Vth and VIth semester
8.	B.Sc.Diary Science and Technology	Vth and VIth semester
9.	B.Sc.Automobile Technology	Vth and VIth semester
10.	B.Sc.Physics	Vth and VIth semester
11.	B.Sc.Chemistry	Vth and VIth semester
12.	B.Sc.Analytical Chemistry	Vth and VIth semester
13.	B.Sc.Polymer Chemistry	Vth and VIth semester
14.	B.Sc.Electronics	Vth and VIth semester
15.	B.Sc.Forensic Science & Cyber Security	Vth and VIth semester
16.	B.Sc.Microbiology	Vth and VIth semester
17.	B.Sc.Fisheries Science	Vth and VIth semester
18.	B.Sc.Mathematics	Vth and VIth semester
19.	B.Sc.Forensic Science	Vth and VIth semester
20.	B.Sc.Information Technology	Vth and VIth semester
21.	B.Sc.Horticulture	Vth and VIth semester
22.	B.Sc.Networking & Multimedia	Vth and VIth semester
23.	B.Sc.Biochemistry	Vth and VIth semester
24.	B.Sc.Industrial Chemistry	Vth and VIth semester
25.	B.Sc.Bioinformatics	Vth and VIth semester

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26.	**B.Sc.Data Science**	**Vth and VIth semester**
27.	**B.Sc.Non-Conventional and Conventional Energy**	**Vth and VIth semester**
28.	**B.Sc.Statistics**	**Vth and VIth semester**
29.	**B.Sc.Computer Science**	**Vth and VIth semester**
30.	**Bachelor of Computer Application**	**Vth and VIth semester**

This is effective from the Academic Year 2026-27 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/AC.No.06/4498-113
Date:- 12.06.2026.

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Deputy Registrar,
Syllabus Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
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.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

Dr. Babasaheb Ambedkar Marathwada University
Chhatrapati Sambhajinagar- 431001

B.Sc. Degree Programme
(Three Year / Four Years (Hons) /Four Years (Hons with Research)

Syllabus
BSc. V & VI Semester
NEP 2020

Subject (Major): CHEMISTRY
(with Minor Chemistry)

Effective from 2026-27

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Chairman
Board of Studies in Chemistry,
Dr. Babasaheb Ambedkar Marathwada
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BSc Third Year: 5th Semester

Students will have to select / declare choice of **one major subject** and **one minor subject** from three major options M1, M2 and M3 (which were opted in the first year)

Course Type	Course Code	Examination Code (To be given by respective BoS)	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	CHE/DSC/T/300	SAC000230 05T	Theory Course **Inorganic Chemistry**	2		2		2+2+2+ 2 = 08
	CHE/DSC/T/301	SAC000230 15T	Theory Course **Spectral Analysis**	2		2		
	CHE/DSC/P/ 326	SAC000232 65P	Practical based on CHE/DSC/T/300 **Inorganic Chemistry**		4		2	
	CHE/DSC/P/ 327	SAC000232 75P	Practical based on CHE/DSC/T/301 **Spectral Analysis**		4		2	
Discipline specific electives Choose any one from DSE/SUB/DSE/T/300 and DSE/SUB/DSE/T/301 And corresponding Practicals	CHE/SUB/DSE/T /300	SBC000230 05T	**Fundamentals of Chromatography**	2		2		2+2= 4
	CHE/SUB/DSE/P /326	SBC000232 65P	Practical based on CHE/DSE/T/300		4		2	
	CHE/SUB/DSE/T /301	SBC000230 15T	**Organic Synthesis**	2		2		
	CHE/SUB/DSE/P /327	SBC000232 75P	Practical based on CHE/DSE/T/301		4		2	
Minor (Choose any two from pool of courses) **It is from different discipline of the same faculty**	CHE/Mn/T/ 300	SCC000230 05T	To be chosen from other discipline of same faculty **Advanced Chemistry I**	2		2		2+2 = 04
	CHE/Mn/T/ 301	SCC000230 15T	To be chosen from other discipline of same faculty **Advanced Chemistry II**	2		2		
VSC (Vocational Skill Courses) (Choose any one from SUB/VSC/T/ 300 and SUB/VSC/T/ 301) and corresponding Practicals	CHE/VSC/T/ 300	SEC000230 05T	Theory Course **Natural and Synthetic Dyes**	2		2		2+2=04
	CHE/VSC/T/ 301	SEC000230 15T	Theory Course **Synthetic Drugs**	2		2		
	CHE/VSC/P/ 326	SEC000232 65P	Practicals based on CHE/VSC/T/ 300		4		2	
	CHE/VSC/P/ 327	SEC000232 75P	Practicals based on CHE/VSC/T/ 301		4		2	
OJT/ FP/CEP/CC/RP	CHE/FP/P/326 Or CHE/CEP/P/326	SKC000232 65P or SLC000232 65P	**Field project** **Community Engagement and service**		4		2	02
				12	**20**	**12**	**10**	**22**

Minor Courses for other Discipline

CHE/Mn/T/ 300 : This is a 2 credit theory course to be designed for other discipline **Advanced Chemistry I**
CHE/Mn/T/ 301 : This is a 2 credit theory course to be designed for other discipline **Advanced Chemistry II**

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BSc Third Year: 6th Semester

Course Type	Course Code	Examination Code (To be given by respective BoS)	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
				Theory	Practical	Theory	Practical	
Major (Core) Mandatory DSC	CHE/DSC/T/ 350	SAC0002350 6T	Theory Course **Organic Chemistry**	2		2		2+2+2+2+ 2= 10
	CHE/DSC/T/ 351	SAC0002351 6T	Theory Course **Physical Chemistry**	2		2		
	CHE/DSC/P/ 376	SAC0002376 6P	Practical based on CHE/DSC/T/350		4		2	
	CHE/DSC/P/ 377	SAC0002377 6P	Practical based on CHE/DSC/T/ 351		4		2	
	CHE/DSC/T/ 352	SAC0002352 6T	IKS2 **Ancient Indian Chemistry**	2		2		
Discipline specific electives Choose any one from DSE/SUB/DSE/T/350 and DSE/SUB/DSE/T/351 And corresponding Practicals	CHE/SUB/DS E/T/350	SBC0002350 6T	**Chemistry of Nano Material and Glass**	2		2		2+2=04
	CHE/SUB/DS E/P/376	SBC0002376 6P	Practical based on CHE/DSE/T/350		4		2	
	CHE/SUB/DS E/T/351	SBC0002351 6T	**Instrumental Method of Chemical Analysis**	2		2		
	CHE/SUB/DS E/P/377	SBC0002377 5P	Practical based on CHE/DSE/T/351		4		2	
Minor (Choose any two from pool of courses) **It is from different discipline of the same faculty**	CHE/Mn/T/35 0	SCC0002350 6T	To be chosen from other discipline of same faculty **Advanced Chemistry III**	2		2		2+2 = 04
	CHE/Mn/T/ 351	SCC0002351 6T	To be chosen from other discipline of same faculty **Advanced Chemistry IV**	2		2		
OJT/ FP/CEP/CC/RP Any one among three	CHE/RP/P/ 376	SOC0002376 6P	Research Project		8		4	04
	CHE/OJT/P/ 376	SJC00023766 P	On Job Training		8		4	
				12	**20**	**12**	**10**	**22**
Exit Option : Award of UG Diploma in major and minor with 88 credits and an additional 4 credits NSQF course (related to major / minor) / Internship during summer vacation OR Continue with Major and Minor								

Minor Courses for other Discipline

CHE/Mn/T/ 350 :This is a 2 credit theory course to be designed for other discipline **Advanced Chemistry III**
CHE/Mn/T/ 351: This is a 2 credit theory course to be designed for other discipline **Advanced Chemistry IV**

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SAC00023005T

CHE/DSC/T/ 300 — **Title of Paper: Inorganic Chemistry**

Total Credits: 02 — Total Contact Hours: 30 Hrs

University Assessment 30 Marks — Internal Assessment 20

Maximum Marks: 30 (UA) + 20 (IA) =50

Learning Objectives of the Course:

1. Understand electronic transitions of transition metal complexes.
2. Analyze absorption spectra of metal complexes
3. Define and classify metal carbonyls, Explain the nature of metal–carbon bonding.
4. Describe methods of preparation of important metal carbonyls.
5. Apply the 18-electron rule to predict stability of metal carbonyl complexes.
6. Explain structure and bonding in important carbonyls.
7. Define and explain the basic principles of Molecular Orbital Theory Describe the formation of molecular orbitals from atomic orbitals.
8. Construct molecular orbital energy level diagrams for simple homonuclear and heteronuclear diatomic molecules. Calculate bond order and predict molecular stability.
9. Differentiate between Molecular Orbital Theory and Valence Bond Theory.
10. Apply MO theory to explain properties such as bond strength, bond length, and spectral characteristics.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Develop a clear understanding of electronic structure and spectral behaviour of transition metal complexes
2. Understand fundamental concepts of organometallic chemistry with emphasis on metal carbonyl chemistry.
3. Analyze bonding in transition metal carbonyls using molecular orbital theory and electron counting rules.
4. Predict structure and geometry of carbonyl complexes based on electron count and ligand behaviour.
5. Explain the assumptions of Molecular Orbital Theory.
6. Construct and interpret molecular orbital diagrams for diatomic molecules.
7. Determine bond order, stability, and magnetic properties using MO theory.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Electronic Spectra of Transition Metal Complexes**: Types of electronic transitions, Selection rules for d -d transitions, Spectro-chemical series,	**10**

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	Orgel Energy level diagram for d^1, d^5 and d^9. Electronic Spectrum of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$complex ion.	
II	**Metal Carbonyl** : Definitions of organometallic compounds and organometallic chemistry, CO as a pi-acid donor ligand, binary metal carbonyl, classification of of metal carbonyls, synthesis of metal carbonyls, direct reaction, reductive carbonylation, photolysis and thermolysis, structure of $Ni(CO)_4$, $Mn_2(CO)_{10}$, $Fe(CO)_5$, $Fe_2(CO)_9$, Hapticity, molecular and electronic structure of binary metal carbonyls, Electronic count in complexes(18 electronic rule)	**10**
III	**Molecular Orbital Theory** : Introduction to Molecular Orbital Method (MOT) and postulates of MO theory, LCAO approximation, s-s combination of orbitals, s-p combination of orbitals, p-p combination of orbitals, p-d combination of orbitals, d-d combination of orbitals, nonbonding combination of orbitals, Rules for linear combination of atomic orbitals, example of molecular orbital treatment for homonuclear diatomic molecules: Explain following molecules with respect to MO energy level diagram, bond order and magnetism: H_2^+ molecule ion, H_2 molecule, He_2^+ molecule ion, He_2 molecule, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, O_2 molecule, O_2^- and O^{2-} ion, F_2 molecule, Heteronuclear diatomic molecules: NO, CO, HF.	**10**

Reference books:

1. Concise Inorganic Chemistry by J. D. Lee, 5th Ed (1996).
2. Principles of Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008.
3. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall,2008.
4. Principles of Inorganic chemistry by Puri, Sharma and Kalia.
5. Inorganic Chemistry by Gurudeep Raj, Chatwal.
6. Inorganic Chemistry by Huheey,Keiter and Keiter.
7. Advanced Inorganic Chemistry Vol. II BY Satyaprakash, Tuli, Basu and Madan.

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SAC00023265P

CHE/DSC/P/326: **Title of Paper: Inorganic Chemistry Lab Course:**

Total Credits: 02
University Assessment 30 Marks
Maximum Marks: 30 (UA) + 20 (IA) =50

Total Contact Hours: 60 Hrs
Internal Assessment 20 Marks

Learning Objectives of the Course:

1. Identify two acidic radicals (anions) and two basic radicals (cations) present in a given inorganic mixture.
2. Understand the principles of qualitative and quantitative chemical analysis.
3. Identify and separate metal ions in a binary mixture using systematic methods.
4. Apply concepts like precipitation, solubility product, and complex formation.
5. Perform volumetric or gravimetric estimation of a selected metal ion..
6. Apply stoichiometric calculations to determine percentage composition and purity.

Course Outcomes (COs):

After completion of the course, students will be able to:

1. Apply principles of qualitative inorganic analysis to identify unknown substances.
2. Demonstrate knowledge of analytical chemistry techniques for metal ion analysis.
3. Systematically separate and identify components of inorganic mixtures.
4. Apply appropriate methods for quantitative estimation of metal ions.
5. Perform quantitative analysis with acceptable experimental accuracy.
6. Calculate percentage yield and percentage purity of prepared compounds.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Semi-micro quantitative Analysis** (Any Five) To detect two acidic and two basic radicals from given inorganic binary mixture.	20 Hrs
II	**Estimations: Separation and estimation of any one metal ion by gravimetry or volumetry from binary Mixture** 1. Fe^{2+} and Al^{3+} 2. Ca^{2+} and Ba^{2+} 3. Fe^{2+} and Zn^{2+} 4. Cu^{2+} and Ni^{2+}	20 Hrs

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	5. Cu^{2+} and Ba^{2+}	
III	**Preparations :** 1. Preparation of Potash Alum, $K_2SO_4 Al_2 (SO_4)_3 .24H_2O$ 2. Preparation of Ferrous ammonium sulphate, $FeSO_4(NH_4)_2 SO_4.6H_2O$ 3. Preparation of Ferrous Oxalate, $FeC_2O_4.2H_2O$ 4. Preparation of Potassium trioxalate Ferrate, $K_3[Fe(C_2O_4)_3].3H_2O$ 5. Nickel Ammonium Sulphate, $NiSO_4.(NH_4)_2.SO_4.6H_2O$	20 Hrs

Reference:

1. A Text book of quantitative Inorganic Analysis - A. I. Vogel.
2. A Text book of qualiitative Inorganic Analysis - A. I. Vogel.
3. Advanced Practical Inorganic Chemistry by Gurudeep Raj.
4. Vogel's. Qualitative Inorganic Analysis revised by G. Svehla.

SAC00023015T

CHE/DSC/T/ 301 **Title of Paper: Spectral Analysis**

Total Credits: 02 Total Contact Hours: 30 Hrs

University Assessment 30 Marks Internal Assessment 20

Maximum Marks: 30 (UA) + 20 (IA) =50

Learning Objectives of the Course:

1. Explain the fundamental principles behind 1H NMR, 13C NMR and mass spectrometry.
2. Describe how these techniques provide structural information about organic molecules.
3. Analyse and interpret ^1H NMR spectra to determine the number and environment of hydrogen atoms in a molecule.
4. Analyse and interpret ^{13}C NMR spectra to identify different carbon environments in a molecule.
5. Interpret mass spectra to determine molecular mass, fragmentation patterns and possible molecular structures.
6. Use combined spectral data (^1H NMR, ^{13}C NMR, and mass spectrometry) to deduce complete molecular structures.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Demonstrate the ability to explain the theoretical foundations and operational principles of ^1H NMR, ^{13}C NMR and mass spectrometry.
2. Accurately interpret and analyse ^1H NMR, ^{13}C NMR, and mass spectra to identify molecular structure, functional groups and chemical environments.
3. Integrate spectral data from multiple techniques to propose and justify the structures of organic compounds.

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4. Explore fragmentation pattern for various functional group and phenomena like the molecular ion peak and McLafferty rearrangement.
Solve structural elucidation problems using real or simulated NMR and mass spectrometry datasets, showcasing critical analysis and reasoning skills.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Proton magnetic resonance spectroscopy**: Principle, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, TMS reference, peak area, integration, spin-spin coupling, coupling constants, J-value, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, carboxylic acids, amines, amides. Problems based on 1H NMR	10
II	**Mass Spectroscopy:** Introduction, Basic Principle, Nature of mass spectrum, Importance of molecular ion peak, base peak, isotopic peaks. Nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation pattern of compounds up to 5 carbons -aldehydes, ketones, alkyl halides and alcohols. McLafferty rearrangement, Retro-Diels-Alder reaction. Problems based on Mass Spectroscopy.	10
III	**^{13}C NMR spectroscopy:** Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons. Structure determination involving individual or combined use of the above spectral techniques. Combined problems based on I.R., Mass, ^{1}H NMR, ^{13}C NMR.	10

Reference books:

1. Organic Spectroscopy, William Kemp, W.H. Freeman & Company.
2. Organic Spectroscopy-Principles and Applications, Jagmohan, Narosa Publication.
3. Organic Spectroscopy, V.R. Dani, Tata McGraw-Hill Publishing Co.
4. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
5. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
6. Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C. Morrill, John Wiley and Sons.

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SAC00023275P

CHE/DSC/P/327: **Title of Paper: Spectral Analysis**
Lab Course:

Total Credits: 02 Total Contact Hours: 60 Hrs
University Assessment 30 Marks Internal Assessment 20 Marks
Maximum Marks: 30 (UA) + 20 (IA) =50

Learning Objectives of the Course:

1. Analyse and interpret ^{1}H NMR spectra to determine the number and environment of hydrogen atoms in a molecule.
2. Analyse and interpret ^{13}C NMR spectra to identify different carbon environments in a molecule.
3. Interpret mass spectra to determine molecular mass, fragmentation patterns and possible molecular structures.
4. Use combined spectral data (^{1}H NMR, ^{13}C NMR, IR and mass spectrometry) to deduce complete molecular structures.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Accurately interpret and analyse ^{1}H NMR, ^{13}C NMR, IR and mass spectra to identify molecular structure, functional groups and chemical environments.
2. Integrate spectral data from multiple techniques to propose and justify the structures of organic compounds.
3. Compare the selectivity, scope, and limitations of commonly used oxidizing and reducing systems.
4. Design simple multistep organic syntheses using suitable reagents and reaction conditions.
5. Analyze reaction outcomes and predict products in reagent-based synthetic problems.
6. Demonstrate awareness of safety, handling, and environmental aspects of important organic reagents

Module No	Topics / actual contents of the syllabus	Contact Hours
I	**a) Green Chemistry Preparations** 1. Nitration of phenol or substituted phenols using $CaNO_3$. 2. Green synthesis of benzhydrol from benzophenone. 3. Green synthesis of acetanilide from aniline using Zn / acetic acid. **b) Organic Preparations** 1. Preparation of 1, 4- dihydropyrimidinone from ethyl acetoacetate, benzaldehyde and urea using oxalic acid as catalyst. 2. Preparation of β-naphthyl methyl ether from β-naphthol. (Methylation by	**30**

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	DMs, NaOH). 3. Preparation of 4-methyl-7-hydroxy coumarin from resorcinol. 4. Preparation of Hippuric acid from Glycine.	
II	**B) Interpretation of IR and NMR spectra** 1. Determination of functional group of organic compound from given IR spectra. 2. Determination of structure of organic compound from given NMR spectra. (Ethyl alcohol, Cis-2-butene, Trans-2-butene, Benzoic acid, Propanaldehyde, Ethyl methyl ether, 1 Butyne, Ethyl acetate, Propyl Cyanide, Salicylic Acid, Nitro phenols, Isopropyl benzene, Propanamine, Benzamide, n-Pentane, 2-chloro butane, Acetophenone)	**30**

Text / Reference Books:

Chemistry Lab Portal

1. Organic Spectroscopy, William Kemp, W.H. Freeman & Company.
2. Organic Spectroscopy-Principles and Applications, Jagmohan, Narosa Publication.
3. Organic Spectroscopy, V.R. Dani, Tata McGraw-Hill Publishing Co.
4. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
5. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
6. Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C. Morrill, John Wiley and Sons Elementary Practical Organic Chemistry, Part I: Small Scale Preparations — Arthur I. Vogel
7. Elementary Practical Organic Chemistry, Part III: Quantitative Organic Analysis — Arthur I. Vogel
8. Advanced Experimental Organic Chemistry — V. K. Ahluwalia and Sunita Dhingra
9. Practical Organic Chemistry — B. S. Furniss, A. J. Hannaford, P. W. G. Smith and A. R. Tatchell
10. Practical Organic Chemistry — F. G. Mann and B. C. Saunders
11. A.I. Vogel – Practical Organic Chemistry
12. Laboratory Manual of Organic Chemistry -R.K. Bansal
13. Advanced Practical Organic Chemistry- N.K. Vishnoi
14. Techniques of Thin-layer Chromatography in Amino Acid and Peptide Chemistry-G. Pataki
15. Handbook of Thin-Layer Chromatography by Joseph Sherma and Bernard Fried.

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SBC00023005T

DSC: CHE/DSE/T/ 300 | **Title of Paper: Fundamental of Chromatography**
Total Credits: 02 | Total Contact Hours: 30 Hrs.
University Assessment 30 Marks | Internal Assessment 20 Marks

Learning Objectives of the Course:

- **After studying this course, students will be able to:**

1. Chromatography focus on understanding separation of complex mixtures-based migration rates.
2. It includes identifying mixture components and polarity, calculating R_f values, applying techniques like TLC, Paper and Gas chromatography.
3. Understand the basic principles and classification of chromatography techniques.
4. Explain the theory of chromatographic separation and column efficiency.
5. Describe the working principles and procedures of Thin Layer Chromatography (TLC).
6. Understand the methods and applications of Paper Chromatography for compound separation.
7. Explain the instrumentation and working of Gas Chromatography (GC).
8. Analyze chromatograms for qualitative and quantitative determination of compounds.
9. Apply chromatographic techniques in chemical and pharmaceutical analysis.

Course Outcomes (CO's) :-

- **After completion of the course, students will be able to.**

1. Stability to set up and operate instruments.
2. Capacity to select appropriate stationary/mobile phase.
3. Interpreting data for qualitative & quantitive Purpose.
4. Explain the fundamental concepts, theory, and classification of chromatographic methods.
5. Demonstrate understanding of column chromatography, ion-exchange chromatography, TLC, and paper chromatography techniques.
6. Describe the principle, instrumentation, and working mechanism of Gas Chromatography.
7. Interpret chromatographic results for identification and estimation of chemical compounds.
8. Apply chromatographic techniques for separation and analysis in laboratory and industrial applications.
9. Learners acquire both theoretical knowledge & Practical, hands-on skills in Separating, identifying and quantifying compounds.

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Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Fundamentals of Chromatography** Introduction and scope of chromatography, Principle of differential migration, Classification and modes of chromatography, Distribution coefficient, Chromatographic parameters: elution time and volume, capacity factor; Column efficiency, resolution, and theoretical plates; Sample preparation techniques.	**10**
II	**A. Paper Chromatography** Principle and types of paper, Modes of development, Sample preparation and spot detection, Retardation factor (Rf) and factors affecting Rf, Applications **B. Thin Layer Chromatography (TLC)** Principle and theory, Stationary phase and mobile phase, Plate preparation, Sample application and development, Visualisation of plate, Rf values and influencing factors, Applications	**10**
III	**A. Column Chromatography** Principle and types (adsorption and partition), Column packing and sample application, Elution and separation process, Applications **B. Ion-Exchange Chromatography** Principle and ion exchangers, Basic operation and applications **C. Instrumental Techniques** **High Performance Liquid Chromatography (HPLC):** Principle, basic instrumentation, applications **Gas Chromatography (GC):** Principle, GSC and GLC, Basic instrumentation and working, Application	**10**

Reference books:

1. Instrumental methods of Analysis 7th Ed Willard, Merritt, Dean, Settle.
2. Principles of Instrumental analysis 5th Ed Skoog Holler, Nieman
3. Instrumentation method of analysis by Gurdeep R. Chatwal and Sham X. Anand.
4. Analytical chemistry by Grow Gary D-Christian
5. Analytical Chemistry by john. H- Canady

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DSC: CHE/DSE/T/ 326 **Title of Paper: Fundamental of Chromatography**

Total Credits: 02 Total Contact Hours: 60 Hrs.

University Assessment 30 Marks Internal Assessment 20 Marks

Learning outcome

After studying this course, students will be able to:

1. At the end of laboratory activity, the students should be able to – perform practical's base on chromatography.
2. Chromatography focus on understanding the separation of complex mixture based on migration rates.
3. It includes identifying mixture components polarity, calculating Rf values and applying techniques like TLC paper, Gas chromatography.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. We understood how chromatography is useful in chemical analysis, forensic science, medicine, and food testing.
2. We understood the TLC and paper chromatography is a simple, economical and efficient method for checking purity and identifying compound.
3. Stability to set up and operate instruments
4. Capacity to select appropriate stationary mobile phase.
5. Interpretating data for quantitative & quantative purpose.
6. Learners acquire both theoretical knowledge & practical hands-on skills in separating, identifying and Qualifying components.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	1. To extract pigments from a medicinal plant. 2. To separate a mixture of plant pigments by batch process. 3. To determine the ion-exchange capacity of Amberlite resin. 4. To separate a mixture of an aldehyde and a carboxylic acid using column chromatography. 5. To separate and identify given amino acids using ascending paper chromatography and calculate their R_f values.	**30**

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	6. To separate sugars using thin layer chromatography (TLC) and determine their R_f values.	
II	1. To purify water using cation and anion exchange resins. 2. To perform paper chromatography on different black ink samples and calculate the Rf values of their components. 3. To separate and identify monosaccharides present in a given mixture using paper chromatography. 4. To check the purity of given API (Rifampicin) by TLC. 5. Separation and identification of metal ions Ni and Cr by paper chromatography. 6. Separation and identification of metal ions Ni and Cu by paper chromatography.	**30**

Reference books:

1. Vogel's Textbook of Practical Organic Chemistry – Arthur I. Vogel
2. Introduction to Chromatography – Victor R. Meyer
3. Instrumental Methods Of Chemical Analysis – H. H. Willard Et Al.
4. Instrumental Methods Of Analysis 7th Edition.
5. Principle Of Instrumental Analysis 5 Th Edition Skoog Holler, Npenan.
6. Instrumentation Method Of Analysis By Gurdeep R Chatwal Sham X Anand.
7. Analytical Chemistry – Gary D. Christian
8. Analytical chemistry by John H Candy

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SBC00023015T

DSC: CHE/DSE/T/ 301 | **Title of Paper: Organic Synthesis**
Total Credits: 02 | Total Contact Hours: 30 Hrs.
University Assessment 30 Marks | Internal Assessment 20 Marks

Learning Objectives of the Course:

1. Explain the principles, classification, and roles of common oxidizing and reducing reagents used in organic synthesis.
2. Predict suitable reagents for specific functional group transformations.
3. Compare the strength, selectivity, and functional group compatibility of different oxidation and reduction systems.
4. Illustrate detailed reaction mechanisms for important reagent-based transformations, including hydride reductions and DMSO-based oxidations.
5. Apply knowledge of reagents to design simple synthetic routes for the preparation of target organic molecules.
6. Evaluate the advantages, limitations, and safety considerations associated with commonly used organic reagents.

Course Outcomes:

At the end of the course, the student will be able to:

1. Classify and describe the functions of important oxidizing and reducing reagents used in organic synthesis.
2. Explain the mechanisms of key reagent-based transformations such as hydride reductions, DMSO-based oxidations, and Birch reduction.
3. Select appropriate reagents for specific functional group interconversions with proper justification.
4. Compare the selectivity, scope, and limitations of commonly used oxidizing and reducing systems.
5. Design simple multistep organic syntheses using suitable reagents and reaction conditions.
6. Analyze reaction outcomes and predict products in reagent-based synthetic problems.
7. Demonstrate awareness of safety, handling, and environmental aspects of important organic reagents.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Reagents:** **Oxidizing Reagents:** DMSO/DCC (Pfitzner–Moffatt oxidation), DMSO/Ac_2O (Swern-type oxidation variant), Dess–Martin periodinane (DMP), Jones reagent (CrO_3/H_2SO_4), OsO_4, SeO_2, $KMnO_4$ **Reducing Reagents:** $LiAlH_4$, $NaBH_4$, DIBAL-H, $NaBH_3CN$, Pd/C, Na/NH_3 (Birch reduction)	**10**

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	Other: **N-Bromosuccinamide (NBS), Diazomethane, Polyphosphoric acid (PPA)**	
II	**Name Reaction:** Sandmeyer, Gatterman, wurtz, Wurtz-Fittig, Stephen, Hell-Volhard-Zelinsky (HVZ), Gabriel phthalimide synthesis, Perkin, Mannich, Diels Alder.Biginelli. Reformatsky Reaction, Michael Addition, Knoevenagel Condensation, Wittig Reaction, Claisen Condensation, Dieckmann's reaction or condensationUllmann Reaction,	**10**
III	**Rearrangement Reactions:** Introduction and Types of Rearrangement reaction. Beckmann, Favorskii, Lossen, Curtius, Schimidt. Hoffmann rearrangement,Benzilic Acid Rearrangement, Pinacol-Pinacolone Rearrangement Fries Rearrangement	**10**

Text / Reference Books:

1.Organic Chemistry by Morrison and Boyd, Print ice hall.
2. Organic Chemistry by L.G. Wade. Print ice hall.
3. Organic Chemistry Vol. I, II, III by S. M. Mukharji, S. P. Sing and R. P. Kapoor
4. Fundamental of organic chemistry by Solomon, John willey
5. A Text book of organic chemistry by Bahl and Bahl.
6. A Text book of organic chemistry by P. L. Soni.
7. Organic Chemistry 05th edition, by: A. K. Pine.
8. Organic Chemistry, by: Solomons Fryhle
10. Organic Chemistry by Francis A. Carey, McGRAW-HILL, INC.
11. Heterocyclic Chemistry by Raj K. Bansal, New Age International
12. Heterocyclic Chemistry by J. A. Joule and K. Mills, Blackwell Science

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SBC00023265P

DSC: CHEM/DSE/P/ 327 | **Title of Paper: Practical Based on Organic Synthesis**
Total Credits: 02 | Total Contact Hours: 60 Hrs.
University Assessment 30 Marks | Internal Assessment 20 Marks

Learning Objectives of the Course:

1. Understand the fundamental concepts and laboratory approaches involved in the synthesis of organic compounds through selected reactions.
2. Apply the principles of green chemistry in the selection of catalysts, reaction media, and experimental conditions.
3. Develop skills in monitoring reaction progress using thin layer chromatography and interpreting chromatographic behavior.
4. Relate experimental transformations to the underlying reaction mechanisms and named reactions studied in theory.
5. Acquire competence in purification, isolation, and basic characterization techniques for organic compounds.
6. Perform quantitative estimation of important organic functional groups using appropriate analytical methods.
7. Demonstrate safe laboratory practices, proper waste management, and systematic recording of experimental observations.

Course Outcomes

At the end of the course, the student will be able to:

1. Execute selected organic syntheses using appropriate laboratory techniques and obtain products with acceptable yield and purity.
2. Apply green chemistry principles in designing and performing environmentally safer organic reactions.
3. Monitor reaction progress and assess completion using thin layer chromatography and interpret Rf values correctly.
4. Explain the reaction mechanisms and named reactions associated with the performed organic transformations.
5. Isolate, purify, and characterize organic compounds using standard laboratory methods.
6. Carry out quantitative estimation of selected organic functional groups with reasonable accuracy and precision.
7. Follow safe laboratory practices, maintain proper records, and manage chemical waste responsibly.

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Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Organic Preparations and TLC Monitoring:** 1. To synthesize a dihydropyrimidinone derivative using benzaldehyde, ethyl acetoacetate, and urea. 2. To prepare Benzalacetophenone (Chalcone) by the Claisen-Schmidt condensation of benzaldehyde and acetophenone in an alkaline medium. a. (ethanol–water + catalytic NaOH) 3. To prepare 7-Hydroxy-4-methylcoumarin by the Pechmann condensation of resorcinol and ethyl acetoacetate . 4. To prepare Hippuric acid by the benzoylation of Glycine (aminoacetic acid) using Benzoyl chloride. 5. To prepare Phthalic anhydride by the thermal dehydration of Phthalic acid. 6. To prepare Benzilic acid (2,2-diphenyl-2-hydroxyacetic acid) by the base-catalyzed rearrangement of Benzil, using sodium hydroxide (NaOH). 7. To prepare Benzilic acid by the base-catalyzed rearrangement of Benzil using sodium hydroxide (NaOH).	20
II	**Organic Preparations with Reaction Monitoring by Thin Layer Chromatography (TLC):** 1. To prepare Aspirin (Acetylsalicylic acid) from salicylic acid using Oxalic acid as a green catalyst. 2. To prepare 3,4-Dihydropyrimidin-2(1H)-one using fruit juice((lemon/orange)) as a natural catalyst. 3. To prepare 3,4-Dihydropyrimidin-2(1H)-one using fruit juice as a natural catalyst. (L-proline, Ammonium acetate, Citric acid) 4. To prepare Benzylidene malononitrile by the condensation of benzaldehyde and malononitrile under solvent-free conditions using a green catalyst. (Grinding) 5. To prepare Benzylideneaniline (a Schiff base) by the condensation of aniline and benzaldehyde using a green catalyst. (PEG, ethylene glycol, Ethyl lactate) 6. To prepare 2-amino-4-phenyl-7-hydroxy-4H-chromene-3-carbonitrile using a one-pot multicomponent reaction (MCR) in the presence of a green heterogeneous catalyst. (basic alumina, K_2CO_3, Silica Gel, Eggshell Powder) 7. To prepare p-Bromophenol by the electrophilic aromatic substitution of phenol using a green brominating system. (KBr/ H_2O_2 or NaBr/H_2O_2 by using Citric acid or boric acid as catalyst)	20
III	**Organic Estimations:** 1. Estimation of Phenol 2. Estimation of Aniline 3. Estimation of ethyl benzoate 4. Estimation of Acetone 5. Estimation of glycine	20

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Reference books:

1. Elementary Practical Organic Chemistry, Part I: Small Scale Preparations — Arthur I. Vogel
2. Elementary Practical Organic Chemistry, Part III: Quantitative Organic Analysis — Arthur I. Vogel
3. Advanced Experimental Organic Chemistry — V. K. Ahluwalia and Sunita Dhingra
4. Practical Organic Chemistry — B. S. Furniss, A. J. Hannaford, P. W. G. Smith and A. R. Tatchell
5. Practical Organic Chemistry — F. G. Mann and B. C. Saunders
6. A.I. Vogel – Practical Organic Chemistry
7. Laboratory Manual of Organic Chemistry -R.K. Bansal
8. Advanced Practical Organic Chemistry- N.K. Vishnoi
9. Techniques of Thin-layer Chromatography in Amino Acid and Peptide Chemistry-G. Pataki

Handbook of Thin-Layer Chromatography by Joseph Sherma and Bernard Fried.

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SCC00023005T

CHE/MN/T/ 300 **Title of Paper: Advanced Chemistry I**
Total Credits: 02 Total Contact Hours: 30 Hrs
University Assessment 30 Marks Internal Assessment 20
Maximum Marks: 30 (UA) + 20 (IA) =50

Learning Objectives of the Course:

1. Explain the preparation, properties, and uses of important compounds
2. Define and classify metal carbonyls, Explain the nature of metal–carbon bonding.
3. Describe methods of preparation of important metal carbonyls.
4. Apply the 18-electron rule to predict stability of metal carbonyl complexes.
5. Explain structure and bonding in important carbonyls.
6. Define and explain the basic principles of Molecular Orbital Theory Describe the formation of molecular orbitals from atomic orbitals.
7. Construct molecular orbital energy level diagrams for simple homonuclear and heteronuclear diatomic molecules. Calculate bond order and predict molecular stability.
8. Differentiate between Molecular Orbital Theory and Valence Bond Theory.
9. Apply MO theory to explain properties such as bond strength, bond length, and spectral characteristics.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Develop a clear understanding of electronic structure and spectral behavior of transition metal complexes
2. Understand fundamental concepts of organometallic chemistry with emphasis on metal carbonyl chemistry.
3. Analyze bonding in transition metal carbonyls using molecular orbital theory and electron counting rules.
4. Predict structure and geometry of carbonyl complexes based on electron count and ligand behaviour.
5. Explain the assumptions of Molecular Orbital Theory.
6. Construct and interpret molecular orbital diagrams for diatomic molecules.
7. Determine bond order, stability, and magnetic properties using MO theory.

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Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Chemistry of Noble gases: Introduction and Position in the Periodic table, Electronic configuration, Compounds of noble gases, under excited condition, through coordination, by physical trapping (Clathrates). Fluorides of xenon: Preparation, properties and structure of XeF2, XeF4, XeF6 , Uses of Noble gases.	**10**
II	**Metal Carbonyl :** Definitions of organometallic compounds and organometallic chemistry, CO as a pi-acid donar ligand, binary metal carbonyl, classification of of metal carbonyls, synthesis of metal carbonyls, direct reaction, reductive carbonylation, photolysis and thermolysis, structure of $Ni(CO)_4$, $Mn_2(CO)_{10}$, $Fe(CO)_5$, $Fe_2(CO)_9$, Hepticity, molecular and electronic structure of binary metal carbonyls, Electronic count in complexes(18 electronic rule)	**10**
III	**Molecular Orbital Theory :** Introduction to Molecular Orbital Method (MOT) and postulates of MO theory, LCAO approximation, s-s combination of orbitals, s-p combination of orbitals, p-p combination of orbitals, p-d combination of orbitals, d-d combination of orbitals, nonbonding combination of orbitals, Rules for linear combination of atomic orbitals, example of molecular orbital treatment for homonuclear diatomic molecules: Explain following molecules with respect to MO energy level diagram, bond order and magnetism: H_2^+ molecule ion, H_2 molecule, He_2^+ molecule ion, He_2 molecule, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, O_2 molecule, O_2^- and O^{2-} ion, F_2 molecule, Heteronuclear diatomic molecules: NO, CO, HF.	**10**

Reference books:

1. Concise Inorganic Chemistry by J. D. Lee, 5th Ed (1996).
2. Principles of Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008.
3. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall,2008.
4. Principles of Inorganic chemistry by Puri, Sharma and Kalia.
5. Inorganic Chemistry by GurudeepRaj,Chatwal.
6. Inorganic Chemistry by Huheey,Keiter and Keiter.
7. Advanced Inorganic Chemistry Vol. II BY Satyaprakash, Tuli, Basu and Madan.

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CHE/MN/T/ 301 **Title of Paper: Advanced Chemistry II**

Total Credits: 02 Total Contact Hours: 30 Hrs

University Assessment 30 Marks Internal Assessment 20

Maximum Marks: 30 (UA) + 20 (IA) =50

Learning Objectives of the Course:

1. Explain the fundamental principles behind 1H NMR, 13C NMR and mass spectrometry.
2. Describe how these techniques provide structural information about organic molecules.
3. Analyse and interpret ^{1}H NMR spectra to determine the number and environment of hydrogen atoms in a molecule.
4. Analyse and interpret ^{13}C NMR spectra to identify different carbon environments in a molecule.
5. Interpret mass spectra to determine molecular mass, fragmentation patterns and possible molecular structures.
6. Use combined spectral data (^{1}H NMR, ^{13}C NMR, and mass spectrometry) to deduce complete molecular structures.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Demonstrate the ability to explain the theoretical foundations and operational principles of ^{1}H NMR, ^{13}C NMR and mass spectrometry.
2. Accurately interpret and analyse ^{1}H NMR, ^{13}C NMR, and mass spectra to identify molecular structure, functional groups and chemical environments.
3. Integrate spectral data from multiple techniques to propose and justify the structures of organic compounds.
4. Explore fragmentation pattern for various functional group and phenomena like the molecular ion peak and McLafferty rearrangement.
   Solve structural elucidation problems using real or simulated NMR and mass spectrometry datasets, showcasing critical analysis and reasoning skills.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Proton magnetic resonance spectroscopy: Principle, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, TMS reference, peak area, integration, spin-spin coupling, coupling constants, J-value, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, carboxylic acids, amines, amides. Problems based on 1H NMR	10
II	Mass Spectroscopy: Introduction, Basic Principle, Nature of mass spectrum, Importance of molecular ion peak, base peak, isotopic peaks. Nitrogen rule, rule of	10

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	13 for determination of empirical formula and molecular formula. Fragmentation pattern of compounds up to 5 carbons -aldehydes, ketones, alkyl halides and alcohols. McLafferty rearrangement, Retro-Diels-Alder reaction. Problems based on Mass Spectroscopy.	
III	**Chromatography** Introduction and classification of chromatographic methods, Principle of chromatographic analysis with match box model, Theoretical plates and column efficiency, Theory, Principle, technique and applications of-Column Chromatography, Ion exchange Chromatography, Thin layer Chromatography, Paper Chromatography, Numerical Problems	10

Reference books:

1. Organic Spectroscopy, William Kemp, W.H. Freeman & Company.
2. Organic Spectroscopy-Principles and Applications, Jagmohan, Narosa Publication.
3. Organic Spectroscopy, V.R. Dani, Tata McGraw-Hill Publishing Co.
4. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
5. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks.
6. Spectrometric Identification of Organic Compounds, R. Silverstein, G.C Bassler and T.C. Morrill, John Wiley and Sons.
7. Instrumental methods of Analysis 7th Ed Willard, Merritt, Dean, Settle.
8. Principles of Instrumental analysis 5th Ed Skoog Holler, Nieman
9. Instrumentation method of analysis by Gurdeep R. Chatwal and Sham X. Anand

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SEC00023005T

CHEM/VSC/T/300 : (Title of Paper) NATURAL AND SYNTHETIC DYES

Total Credits : 02 Total Contact Hours : 30 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

Learning Objectives of the Course (LOs) :

i) To educate about various dyes and its preparation.
ii) To impart knowledge in the field of various natural and synthetic dyes.
iii) To be able to extend their knowledge to various textile industry.
iv) To aware about the impact of dyes on ecosystem and its remediation.

Course Outcomes (COs) :

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

i) Get basic knowledge of various natural dyes and its applications.
ii) Understand the various basic concepts which are related to dyes.
iii) Comprehend skills of reactions interpretations related to synthetic dyes. .
iv) Learn and apply the knowledge of color and constitutions in daily life.
v) Know the various methods of synthesis and uses of various synthetic dyes.
vi) Aware about adverse effects of dyes on ecosystem and its remedies.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Natural Dyes** Definition of dyes, colour and constitution(Electronic concept of dye),Valence bond theory (Auxochrome and Chromophore), Molecular orbital theory σ, π and ŋ electrons transition), Definition of natural dye, Classification of natural dyes (on basis of hues, origin and chemical constitution),extraction process of color component from natural dyes (Aqueous extraction, non-aqueous extraction) Characterization of natural dyes by UV-Visible spectroscopy),Mordants, Examples and uses of natural dyes (Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll-Names of the chief dying material(s) in each (Structure not expected)	**10 Hrs**

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II	**Synthetic Dyes** Colour and constitution, Classification of dyes based on chemical constitution, Acid dyes, Direct dyes, Reactive dyes, Vat dyes, Sulfur dyes, Metal complex dyes, Azo dyes, Disperse dyes, Basic dyes (Explanation with one example of each) Synthesis and uses of Methyl orange (Azo dye), Malachite green, Congo red, Crystal violet, Alizarin, Indigo, Phenolphthalein, Isatin.	**10 Hrs**
III	**Impact of Dyes on Ecosystem and Remediation** **Impact of Dyes on Ecosystem:** Introduction, Impact bon water, Impact on soil, Impact on air emissions, Impact on human health. **Remediation:** Optimization of dying process, Wastewater treatment, Oxidative process, Role of sodium hypochlorite (NaOCl),Photochemical degradation and techniques, electrochemical destruction, Use of supercritical carbon dioxide in dyeing, Awareness to go green, Pollution prevention, Effluent treatment plant.	**10 Hrs**

Text / Reference Books:

1) Chemistry of Synthetic Dye (Volume I,II and VI) :Venkatraman: K., Academic Press 1972
2) The Chemistry of Synthetic Dyes and Pigments: Lubs H.A., Robert E Krieger Publishing Company, NY, 1995
3) Chemistry of Dyes and Principles of Dyeing: Shenai V.A., Sevak Publications, 1973
4) Natural Dyes and Application to Textiles: Gulrajani M L & Gupta, Department of textile
5) Technology, Indian Institute of Technology, New Delhi, India, 1992
6) Synthetic Dyes: Gurudeep R. Chatwal.
7) Chemistry of Dyes and Principles of Dying: V.A. Shenai, Sevak Publication, Bombay
8) Introduction to dyes: Rastogi
9) Industrial Dyes: K. Hunger, Wiley-VCH publication
10) Natural Dyes for Textiles: Sources, Chemistry and Applications: P. S. Vankar, Wood head Publishing, Cambridge, UK,2017.

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11) The Chemistry of Dyestuffs: A Manual for Students of Chemistry and Dyeing, M. Fort and L. L. Lloyd.

12) Impact of Textile dyes on public health and the environment: Edited by Khursheed Ahmed Wani, IGI Global 2019.

13) Textiles and Clothing: Environmental Concerns and solutions: Edited by Mohd. Shabbir, Wiley publication.

14) Handbook of Textile Effluent Remediation: Edited by Mohd. Yusuf, CRC Press, 2018

SEC00023265P

CHEM/VSC/P/326: (Title of Paper) Natural and synthetic dyes
Lab Course

Total Credits : 02 | Total Contact Hours : 60 Hrs
Summative SEE: 30 Marks | Formative CIA : 20 Marks

Learning Objectives of the Course (LOs) :

After successful completion of this laboratory course, students will be able to:

1. Explain the classification, chemistry, and applications of dyes and acid–base indicators.
2. Describe the relationship between chemical structure and colour in organic compounds.
3. Perform diazotization and coupling reactions for the preparation of azo dyes.
4. Synthesize azo dye derivatives such as Methyl Orange and Methyl Red using appropriate laboratory techniques.
5. Prepare triphenylmethane dyes such as Crystal Violet and Malachite Green.
6. Interpret reaction mechanisms involved in dye formation.
7. Synthesize acid–base indicators including Phenolphthalein.
8. Prepare fluorescent dyes such as Fluorescein and evaluate their properties.
9. Apply suitable dyeing methods for cotton using direct dyes.
10. Perform dyeing of wool and silk using acid dyes and optimize dyeing conditions.
11. Assess washing, light, and heat fastness properties of dyed fabrics.
12. Analyse factors affecting dye uptake, shade development, and fastness characteristics.
13. Follow safe laboratory practices while handling dyes, reagents, and textile materials.
14. Maintain experimental records, calculate yields, and interpret experimental observations.

1. **Course Outcomes (COs) :**
2. After completion of the course, students will be able to -

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3. Demonstrate proficiency in the synthesis of azo dyes through diazotization and coupling reactions and explain the underlying reaction mechanisms.
4. Synthesize important organic dyes and indicators such as Methyl Orange, Methyl Red, Crystal Violet, Malachite Green, Phenolphthalein, and Fluorescein with appropriate purification and characterization techniques.
5. Apply principles of dye chemistry to dye cotton, wool, and silk fabrics using suitable classes of dyes and controlled dyeing conditions.
6. Evaluate the performance of dyed textiles by conducting washing, light, and heat fastness tests and interpreting the results.
7. Correlate molecular structure with colour, indicator behaviour, fluorescence, and dye–fiber interactions in practical applications.
8. Employ good laboratory practices, safety procedures, data analysis, and technical reporting skills in dye synthesis and textile dyeing experiments.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	1. Preparation of Azo Dye by diazotization (e.g., Aniline → Orange dye) 2. Synthesis of Methyl Orange indicator 3. Preparation of Methyl Red 4. Synthesis of Crystal Violet dye 5. Preparation of Malachite Green dye 6. Synthesis of Phenolphthalein indicator 7. Preparation of Fluorescein dye 8. Dyeing of cotton fabric using direct dyes 9. Dyeing of wool/silk using acid dyes 10. Study of fastness properties of dyes (washing, light, heat)	**60 Hrs**

Text / Reference Books:

1) Vogel's Textbook of Practical Organic Chemistry
2) Experimental Organic Chemistry by R.K. Bansal
3) Advanced Practical Organic Chemistry by N.K. Vishnoi
4) Practical Chemistry by O.P. Pandey, D.N. Bajpai and S. Giri
5) Medicinal Chemistry by Ashutosh Kar
6) A Textbook of Organic Chemistry by Arun Bahl and B.S. Bahl
7) Organic Chemistry by O.P. Tandon

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SEC00023015T

CHEM/VSC/T/301: (Title of Paper) SYNTHETIC DRUGS

Total Credits : 02 Total Contact Hours : 30 Hrs
Summative SEE: 30 Marks Formative CIA : 20 Marks

Learning Objectives of the Course (LO's)

1. To describe synthetic pathways of prominent drug classes starting from simple precursors.
2. To design new chemical entities and optimizing existing drug molecules to maximize efficacy and minimize side effects.
3. To provide opportunity for students, as the field opens up diverse and rewarding career paths, such as Medicinal Chemist, Research and Development (R&D) Scientist, and Quality Control Specialist within the pharmaceutical industry and regulatory agencies
4. To apply the knowledge and understanding of drug chemistry to research.
5. To procure proper comments about SARs, metabolism and related toxicity, drug production, chemical and metabolic drug-drug interaction.
6. To discuss chemical classification, chemical name, chemical structure of various drugs.

Course Outcomes (CO's): After completion of the course, students will be able to -

1. Get basic knowledge of drug and its classification based on therapeutic action..
2. Explain how specific chemical structures and functional groups dictate the biological activity of drug molecules.
3. Determine how altering chemical substituent's affects drug potency, toxicity, and target receptor binding affinity.
4. Design and outline the step-by-step chemical synthesis of important classes of therapeutic agents.
5. Detail the named chemical reactions involved in constructing key drug scaffolds.
6. Apply stereo chemical concepts to explain why different optical isomers or enantiomers exhibit varying therapeutic or toxicological outcomes.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	Introduction, Qualities of good drug, Classification of drug based on their therapeutic action, Factors affecting ability of drugs to reach active site.	**10 Hrs**

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	SAR, Mechanism of action and Synthesis (at least one convenient synthetic route) of drugs for following classes: **Sulfonamides**: Sulfacetamide, Dapsone and Sulphaguanidine **Antibiotics:** Ampicillin and Chloramphenicol. **Anti-hypertensive:** Verapamil, Captopril	
II	**Antifungal:** Clotrimazole and Miconazole, **NSAIDs:** Aspirin, Ibuprofen, Paracetamol, Diclofenac and Aceclofenac. **Anthelmintics:** Albendazole and Thiabendazole **Local Anesthetics:** Procaine and Butamben. **Insulin and Oral Hypoglycemic Agents:** Tolbutamide and Chlorpropamide	**10 Hrs**
III	**Sedatives and Hypnotics:** Phenobarbital and Methylphenobarbital **Antipyretics Analgesics:** Paracetamol, Cinchophen and Mefenamic acid. **Cardiovascular drugs:** Methyldopa and Procainamide **Diuretics:** Chlorothiazide and Furosemide **Antihistamines:** Antazoline hydrochloride and fexofenadiene.	**10 Hrs**

Text / Reference Books:

1) Medicinal chemistry-Burgers (Vol: I-IV)
2) Medicinal Chemistry-Ashutosh Kar, New Age International, Delhi
3) Principles of medicinal chemistry-William O Foye
4) Comprehensive medicinal chemistry- Corwin and Hansch
5) Textbook of medicinal chemistry- Vol-I & II-Surendra N Pandey
6) Principles of medicinal chemistry- S S Kadam, K R Mahadik and K G Bothara
7) Introductory medicinal chemistry- Kennewell and Taylor
8) Text book of Organic medicinal and Pharmaceutical chemistry- Jaimes N Delgado and William A Remere
9) Principles of Medicinal Chemistry- Foye's
10) Introduction to principles of drug design- Smith and Williams.
11) Remington's Pharmaceutical Sciences.
12) FOYE's Principles of Medicinal Chemistry(VI Edition)-Thomas L. Lemke, David A.Wiliams, V.F. Roche and William Zito.
13) Introduction of Medicinal Chemistry-A. Gringuage, Wiley –VC
14) Synthesis of Essential Drugs-R.S. Vardanyan and V.J.Hruby

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15) Medicinal Chemistry-David J.Triaggle

SEC00023275P

CHEM/VSC/P/327: (Title of Paper) Synthetic drugs Lab Course

Total Credits : 02 Total Contact Hours : 60 Hrs
Summative SEE: 30 Marks CIA : 20 Marks

Learning Objectives of the Course (LOs) :

After successful completion of this laboratory course, students will be able to:

1. Explain the principles, reaction mechanisms, and pharmaceutical significance of the synthesis of selected medicinal compounds such as aspirin, paracetamol, benzocaine, sulfanilamide, barbituric acid, and iodoform.
2. Perform laboratory synthesis of pharmaceutical compounds using appropriate reagents, reaction conditions, purification, and isolation techniques.
3. Apply laboratory safety practices, good laboratory procedures (GLP), and proper handling of chemicals during synthesis and analysis.
4. Conduct qualitative identification of functional groups present in pharmaceutical substances using standard chemical tests.
5. Employ quantitative analytical techniques such as titration and spectrophotometry for drug estimation and quality assessment.
6. Calculate percentage yield, purity, concentration, assay values, and interpret experimental data accurately.
7. Evaluate the antimicrobial activity of selected drugs using suitable microbiological techniques and analyze the results.
8. Prepare laboratory records, report experimental findings, and communicate scientific observations effectively.

Course Outcomes (COs) :

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

1. Demonstrate the synthesis, purification, and characterization of selected pharmaceutical compounds including aspirin, paracetamol, benzocaine, sulfanilamide, barbituric acid, and iodoform.
2. Apply principles of organic chemistry and medicinal chemistry to understand reaction pathways involved in pharmaceutical compound preparation.
3. Perform qualitative analysis for identification of functional groups and assess the chemical properties of drug molecules.
4. Utilize analytical methods such as acid-base titration and UV-Visible spectrophotometry for quantitative estimation of pharmaceutical compounds.
5. Interpret experimental data to determine drug quality parameters such as purity, assay, and percentage yield.
6. Evaluate the antimicrobial effectiveness of selected drugs and correlate the results with their therapeutic applications.

i) Demonstrate competence in laboratory safety, chemical handling, documentation, and professional laboratory practices.

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ii) Develop problem-solving, critical thinking, and scientific reporting skills required in pharmaceutical analysis and drug development laboratories.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	1. Preparation of Aspirin 2. Synthesis of Paracetamol 3. Preparation of Benzocaine 4. Synthesis of Sulfanilamide 5. Preparation of Barbituric Acid 6. Preparation of Iodoform 7. Estimation of Aspirin by titration 8. Estimation of Paracetamol using spectrophotometry 9. Identification of functional groups in common drugs 10. Study of antimicrobial activity of selected drugs	**60 Hrs**

Text / Reference Books:

1) Vogel's Textbook of - Practical Organic Chemistry – A.I.Vogel
2) Practical Pharmaceutical Chemistry (Part I & II) - A. H. Beckett and J. B. Stenlake
3) Experimental Organic Chemistry by R.K. Bansal
4) Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry - John H. Block, John M. Beale Jr., and Wilson & Gisvold
5) Advanced Practical Organic Chemistry by N.K. Vishnoi
6) Practical Chemistry by O.P. Pandey, D.N. Bajpai and S. Giri
7) Pharmaceutical Organic Chemistry – Ashutosh Kar
8) Practical Microbiology – R. C. Dubey & D. K. Maheshwari

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SKC00023265P

CHEM/FP/T/326: (Title of Paper) **Field Project**

Total Credits : 02 Total Contact Hours : 60 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

OR

SLC00023265P

CHEM/CEP/P/326: (Title of Paper) Community Engagement and Service

Total Credits : 02 Total Contact Hours : 60 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

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SIXTH SEMESTER

SAC00023506T

CHE/DSC/T/350 **(Organic Chemistry) : Theory Course**

Total Credits : 02 Total Contact Hours : 30 Hrs

University Assessment 30 Marks Internal Assessment 20 Marks

Maximum Marks : 50

Learning Objectives of the Course:

1. Explain classification of carbohydrates, structures of monosaccharides.
2. Illustrate concept of anomer, epimer, reducing and non-reducing sugars,
3. To understand concept Mutarotation, Inversion of sugar, reactions of glucose and glyosidic bonds in polyssacharides.
4. Explain classification of amino acids and reactions with various reagents with their significance, peptide bonds.
5. Explain classification of proteins, structure of proteins.
6. To aware students about nomenclature and classification of heterocyclic compounds.
7. To acquaint students about aromaticity, synthesis and reactions of heterocyclic compounds with one hetero atom.
8. To inform students about the condensed heterocycles with their synthesis.

Course Outcomes (COs):

After completion of the course, students will be able to –

1. To understand classification of carbohydrates, structures of monosaccharidesm.
2. Differentiate between anomer, epimer and, reducing and non-reducing sugars
3. To understand Mutarotation, reactions of glucose and glyosidic bonds.
4. Able to understand classification of amino acids and reactions with various reagents with their significance, peptide bonds.
5. To understand the classification of proteins, structure of proteins.
6. To understand the nomenclature and classification of heterocyclic compounds
7. To understand aromaticity, synthesis and reactions of heterocyclic compounds with one hetero atom.
8. Able to understand condensed heterocycles

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Carbohydrates** Introduction, Definition of carbohydrates, General formula and basic structure, Classification of Carbohydrates, Open-chain and cyclic structures of	**10 Hrs**

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	Glucose and Fructose, Concept of anomers, epimers, Reducing and non-reducing sugars, mutarotation and inversion of sugar. Reactions of Glucose with acid, base, phenyl hydrazine, oxidising and reducing agents, Glyosidic bonds. Biological importance of carbohydrates in living organisms.	
II	**a) Amino Acids** Amino acids: classification of amino acids, concept of ampholytes, isoelectric Ph, zwitter ions, titration curves of glycine. Reaction of amino acids with Ninhyrin,Sanger's. Dansyl chloride and Eddman's reagents with their significance. Peptide bond and it's features. **b) Proteins** Classification of proteins based on function, nutrition and composition, Structural organizations of proteins-primary, secondary, tertiary and quaternary structures.	**10 Hrs**
III	**Heterocyclic compounds** Classification and nomenclature, Molecular Orbital Structure, aromaticity in pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions of Pyrrole, furan, thiophene and Pyridine. Furan- Preparation from Ammonium mucate and by Pall-Knorr synthesis. Pyrrole-Preparation from 1,4 dicarbonyl compound and by Fiest – Benary synthesis. Thiophene- Preparation from 1,4 dicarbonyl compound and Sodium succinate. Pyridine – Preparation from 1,5 dicarbonyl compound and by Hantzsch synthesis. Reactions - Nitration, Sulphonation, Acylation and Catalytical reduction, Ring expansion reaction of pyrrole. Condensed Heterocyles: Introduction, Preparation of Quinoline (Skraups Synthesis).Fiesher Indole synthesis.	**10 Hrs**

Text / Reference Books:

1.Organic Chemistry by Morrison and Boyd, Print ice hall.
2. Organic Chemistry by L.G. Wade. Print ice hall.
3. Organic Chemistry Vol. I, II, III by S. M. Mukharji, S. P. Sing and R. P. Kapoor
4. Fundamental of organic chemistry by Solomon, John willey
5. A Text book of organic chemistry by Bahl and Bahl.
6. A Text book of organic chemistry by P. L. Soni.
7. Organic Chemistry 05th edition, by: A. K. Pine.
8. Organic Chemistry, by: Solomons Fryhle
10. Organic Chemistry by Francis A. Carey, McGRAW-HILL, INC.
11. Heterocyclic Chemistry by Raj K. Bansal, New Age International
12. Heterocyclic Chemistry by J. A. Joule and K. Mills, Blackwell Science

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SAC00023766P

CHE/DSC/P/ 376 **(Organic Chemistry) Lab Course**

Total Credits : 02 Total Contact Hours : 60 Hrs

University Assessment 30 Marks Internal Assessment 20 Marks

Maximum Marks : 50

Learning Objectives of the Course:

Course Objective:

1. To identify carbohydrates and proteins qualitatively.
2. To separate sugars and amino acids by chromatography.
3. To do the quantitative analysis by estimations of sugars and amino acids.
4. To get skill of preparation of organic compounds.

Course Outcomes

At the end of the course, the student will be able to:

1. Students can be able to carbohydrates and proteins qualitatively
2. Students able to separate sugars and amino acids by chromatography.
3. Students able to do the quantitative analysis by estimations of sugars and amino acids.
3. Students get knowledge about preparation of some organic compounds

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Chromatography (Separation and identification) Any five** a) To determine Rf value and identify phenylalanine and glycine from the given sample by ascending paper chromatography. b) To determine Rf value and identify leucine and glutamic acid from the given sample by ascending paper chromatography. c) To determine Rf value and identify alanine and aspartic acid from the given sample by ascending paper chromatography. d) To separate the mixture of D-galactose and D-fructose using ascending paper chromatography. e) To separate the mixture of D-Glucose and D-fructose using ascending paper chromatography. f) To separate amino acid mixture glycine and alanine by TLC. g) To separate amino acid mixture glycine and aspartic acid by TLC.	**20 Hrs**

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II	**Quantitative analysis: (estimation) any five.** **a)** Estimation of glycine by Sorenson's method. **b)** Estimation of alanine by Sorenson's method. **c)** Estimation of aspartic acid by Sorenson's method. b) Estimation of glucose by iodination method. c) Estimation of glucose by Fehling's method, d) Estimation of fructose by Benedict's method. e) Estimation of total sugars in a sample by Anthrone method. f) Estimation of carbohydrate in a food sample by Phenol-Sulfuric Acid method .	**20 Hrs**
III	**Organic Preparation: (Any five) [Weight of crude product, percentage yield, recrystallization of crude product and its melting point expected]** a) Preparation of Glucosazone from Glucose. b) Preparation Fructasazone from fructose. c) Preparation of 2,4-Dintrophenyl derivative of glycine. d) Preparation of 2,4-Dintrophenyl derivative of leucine. e) Preparation of phthaloyl derivative of glycine. **f)** Preparation of phthaloyl derivative of alanine g) Preparation of 2,5-Dimethylpyrrole from hexane -2,5-dione. h) Preparation of 2,5-Dimethylfuran from hexane -2,5-dione. i) Preparation of 2-Phenylindole from phenyl hydrazine.	**20 Hrs**

Reference books:

1) Elementary Practical Organic Chemistry, Part I: Small Scale Preparations — Arthur I. Vogel
2) Elementary Practical Organic Chemistry, Part III: Quantitative Organic Analysis — Arthur I. Vogel
3) Advanced Experimental Organic Chemistry — V. K. Ahluwalia and Sunita Dhingra
4) Practical Organic Chemistry — B. S. Furniss, A. J. Hannaford, P. W. G. Smith and A. R. Tatchell
5) Practical Organic Chemistry — F. G. Mann and B. C. Saunders
6) A.I. Vogel – Practical Organic Chemistry
7) Laboratory Manual of Organic Chemistry -R.K. Bansal
8) Advanced Practical Organic Chemistry- N.K. Vishnoi
9) Techniques of Thin-layer Chromatography in Amino Acid and Peptide Chemistry-G. Pataki
10) Handbook of Thin-Layer Chromatography by Joseph Sherma and Bernard Fried.

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SAC00023516T

CHE/DSC /T/351 : **(Title of Paper) PHYSICAL CHEMISTRY**

Total Credits : 02 Total Contact Hours : 30 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

Learning Objectives of the Course:

1. To distinguish between strong and weak electrolytes and explain their behavior regarding molar conductivity.
2. To study Debye Huckel theory of conductance. Specifically focusing on concepts of ionic atmosphere, relaxation effect and electrophoretic effect.
3. To derive and analyse Debye Huckel Onsager equation, including understanding its validity and limitation in practical applications.
4. To calculate electrochemical parameters like ionic strength, activity and activity coefficient for strong electrolytes solutions.
5. To Apply the Debye Huckel Limiting Law include its derivation and various modification used to describe electrolyte behaviour.
6. Express the concentration of solution components using mole fraction and molality.
7. Describe the effect of solute concentration on various solution properties like vapour pressure, boiling point, freezing point and osmotic pressure.
8. Perform calculations using the mathematical equations that describe this various colligative effect.
9. Describe the process of distillation and its practical application.
10. Explain the process of osmosis and describe how it is applied industrially and in nature.
11. To define and differentiate between ideal and non ideal solution
12. To identify the thermodynamic conditions for an ideal solution.
13. To explain why and how non ideal solution shows positive or negative deviations from Rault's law due to changes in intermolecular interactions.
14. To analyse the graphical representation (vapour pressure vs Composition curves) for both solutions types.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Differentiate between strong and weak electrolyte and explain their molar conductivity variations
2. Explain the Debye –Huckel theory of conductance, including the specific impacts of the relaxation effect and electrophoretic effect on ionic mobility.
3. Derive and demonstrate the validity of Debye –Huckel – Onsagar equation for strong electrolyte.

4. Calculate critical electrochemical parameters including ionic strength, activity and activity coefficients of electrolytes.
5. Utilize the Debye-Huckel Limiting law to predict the behavior of ions in dilute solutions.
6. Solve complex numerical related to conductivity and ionic interactions.
7. Understand these properties depend solely on the number of solute particles rather than their chemical identity.
8. Learn the four primary colligative properties, relative lowering of vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure.
9. To utilize Rault's law and Vant Hoff's law to calculate the concentration magnitude.
10. To calculate unknown molecular mass or molar mass of a given solute.
11. Explain how electrolyte cause greater changes in colligative properties compared to nonelectrolytes, utilizing the Van't Hoff factor.
12. Understand the distinction between ideal and non-ideal solution based on Raoult's law.
13. Learn how intermolecular forces of attraction dilute solution behaviour.
14. Identify the changes in enthalpy and volume for ideal solution and how they differ for non ideal solutions.
15. Analyse positive and negative deviations from Raoult's law , including the formation of azeotropes.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Electrochemistry** Strong electrolytes, weak electrolytes and molar conductivity, Debye Huckel theory of conductance, Ionic atmosphere, relaxation effect, Electrophoretic effect, Debye Huckel Onsagar equation, validity and derivation of the Debye Huckel Onsagar equation, ionic strength, activity and activity coefficient of the strong electrolyte, Debye Huckel limiting law , Derivation and modification of Debye Huckel limiting law , Numerical	10
II	**Colligative properties of dilute solution:** Introduction, Solution, electrolytes and non electrolytes, Meaning of the term colligative property, relative lowering of vapour pressure of the solvent in solution, elevation in boiling point of solvents in solution, Landsberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hartley method, application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight, Relation between Vant Hoff"s factor and degree of dissociation of electrolyte by colligative property, Numerical.	10
III	**Ideal and Non ideal Solution**	10

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University, Chh.Sambhajinagar (M.S)

	Introduction to solution, concentration units, Raoult's law, Ideal solution, vapour pressure of ideal solution, activity and activity coefficient, vapour pressure of non-ideal solution, vapour pressure- composition and boiling point, composition curves of miscible solutions, partially miscible liquid, phenol water, trimethylamine-water, Nicotine- water system, effect of impurity on consolute temperature, Numerical	

References books:

1. Physical Chemistry Atkins, P. W. Paula, J. ;Physical Chemistry, Oxford Publication, 11th edition
2. Physical Chemistry – R. A. Alberty, R. I. Billy, John Wiley-1995
3. Physical Chemistry – G. M. Barrow, Tata Mc- Graw Hill-1988
4. Physical Chemistry by Alberty and Silby, Jolly Wiley.
5. Principles of Physical Chemistry by B. R. Puri , L. R. Sharma, M. S. Pathania.
6. Essentials of Physical Chemistry by Bahl Tuli –Revised, S. Chand and Company Ltd.
7. Principles of Physical Chemistry, Fourth Edition by S. H. Marron and C. F. Pruton.
8. Physical Chemistry -4thEdition –Gilbert W. Castellan Narosa.

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SAC00023776P

DSC: CHE/DSC/P/ 377 | **Title of Paper: Physical Chemistry**
Total Credits: 02 | **Hours: 4 Hrs.**
University Assessment 30 Marks | **Internal Assessment 20 Marks**

Question No	Title of the questions	Marks
1	**Instrumental Methods Experiments (Any Eight)** **Refractometry** 1. To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C. 2. Determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution **Colorimetry** 1. To determine equilibrium quotient for the formation of monothiocynato iron (III) complex by colorimetric measurement. 2. Determine the concentration of Cu^{2+} ion in given solution titrating with EDTA solution by colorimetric measurement. **pH -metry** 1.To determine pKa values of the given organic acid by pH measurements. 2. To determine the dissociation constant of dibasic acid (Oxalic acid). 3.To determine the proton -ligand stability constant of an organic acid and the metal ligand stability constant of it's complex by p^H measurements. **Conductometry** 1. Titration of oxalic acid with strong alkali solution. 2. Titration of a mixture of weak acid and strong acid with strong alkali. 3. To determine concentration of sodium acetate solution by titrating it conducto metrically with standard HCl solution. **Potentiometry** 1. Potentiometric titration of a strong acid (HCl) with a weak base(NH_4OH) 2.Determination of the composition of a mixture of acids (HCl and CH_3COOH) mixture with NaOH **Polarimetry** 1. Determination of concentration of a given solution of an optically active substance (say cane sugar) by polarimetric measurements. 2. To study the inversion of cane sugar by polarimeter.	30

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2	**Non instrumental Experiments (Any Seven)** 1. To determine the surface tension of a liquid by stalagmometer method. 2. To study the effect of surfactants on surface tension of water by using stalagmometer . 3. To Determination of partition coefficient of iodine between water and carbon tetrachloride. 4. Determine the solubility of benzoic acid in water at different temperature and hence its heat of solutions . 5. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of 0.5 N H_2SO_4. 6. To Study the effect of addition of an electrolyte (NaCl or KCl or Na_2SO_4) on the solubility of monobasic organic acid (benzoic acid) at room temperature. 7. Determination of interfacial tension between two immiscible liquids say benzene and water at room temperature. 8. To investigate the kinetics of iodination of acetone. 9.Determine rate constant of the reaction between $K_2S_2O_8$ and KI having equal concentration of the reaction species. (a=b). 10. Investigate reaction between Hydrogen peroxide and potassium iodide kinetically. 11.To investigate the influence of ionic strength on the rate constant between potassium persulphate and potassium iodide.	30

Reference books:

1. Vogel's Text book of Quantitative Chemical Analysis, 3rd, 6th Ed. A. I. Vogel J. Mendham, et al, Addison Wesley Publishing Co.
2. Experiments in Chemistry by D. V. Jahagirdar, Himalaya publication 2014
3. Systematic experimental physical chemistry by S. W. Rajbhoj, T. K. Chondekar, Anjali publication.
4. Practical Physical Chemistry, Vishwanathan and Raghwan Viva book
5. Practical Chemistry by O.P. Pandey, D.N. Bajpai & S. Giri, S. Chand & Company Ltd.
6. Senior Practical Prysical Chemistry by B. D. Khosla, V. C. Garg and A. Gulati, S. Chand & Co. New Delhi (2011)
7. Experiments in Physical Chemistry by C. W. Garland, J.W. Nibler & D.P. Shoemaker, 8th Ed: McGraw-Hill New York (2003)
8. Experimental Physical Chemistry by A.M. Halpern & G.C. McBane. 3rd Ed: W.H. Freeman & Co.. New York (2003)
9. Advaced Physical Chemistry Experiment by Gurtu and Gurtu, Pragati Publication.

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SAC00023526T

CHE/DSC /T/352 : **(Title of Paper) IKS2 Ancient Indian Chemistry**

Total Credits : 02 Total Contact Hours : 30 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

Course Outcomes (COs):

At the end of Understand the course student will be able to

1. Know the Indian Knowledge systema and its significance in the protection of traditional knowledge.
2. Understand the need of Indian Knowledge system IKS and significance of the ancient Indian chemistry
3. Relate the various concepts of ancient chemistry with the concepts of modern chemistry the
4. Organize the contribution of made by the ancient Indians in the field of science and chemistry in particular and related concepts
5. Need of the contribution of Indian in the basics of organic farming
6. Outline the chemistry heritage of ancient and India.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Ancient Indian Chemistry** From alchemy to chemistry: Early chemical techniques, technology and arts, different areas of the development in ancient India: Glass making literary cources foreign travellers account, archaeological evidences) Paints and Dyes, perfumes and cosmetics chemicals in ancient India Paper and ink making alcoholic liquors. **Indian Alchemy in medicines** Rasayanas, Etymology of Rasayana Rasayana as Elixir, the position of Rasayana in the medicines Charaka and two categories of medicines, herbal Rasayana, metallic preparations as Rasayana, Iron as reducing agent, Charaka's incidental mention of gold preparations. Calcined metals as Phlogiston, Calcined metals as alchemical preparations, Pulverization of calcined metals calcined gold as the ideal Herbo metallic preparation, Indian alchemy 500 AD Indian Alchemy 1000 AD.	10
II	**Metallurgy In India** Primary texts on metallurgy in India: Rig Veda (Tr Adapted from RTH Griffith) Artha sastra (Tr R P Kangle), Varahamihira (b	10

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	485CE), Khadgalaksanam (tr Vibha Tripathi), Nagarjuna (7th or 8th century CE), Rasendramangalam (tr. HS Sharma) Vagbhata(13th Century) Rasaratnasamuccaya (tr Insa), Classification of metals survarna (Gold) Varieties, Description of different types of Suvarna, pharmaco therapeutic properties of Gold. Rajata (Silver) varieties, Description of different types of rajata, pharmaco therapeutic properties of Silver. Tamra(Copper) varieties, Description of different types of tamra, pharmaco therapeutic properties of Tamra. Loha (Iron) varieties, pharmaco therapeutic properties, Naga/ sisa(lead) physical properties of lead, pharmaco therapeutic properties of leaf, Pittala (brass) Varieties, physical properties of superior and inferior Pittala Pharmaco therapeutic properties of Pittala	
III	**Knowledge of fundamental concepts of chemistry**: concept of atom, nano particles, metallurgy in India (Extraction, purification, alloying process) copper iron, Zinc, Gold and silver. **Contribution of Indian chemists**: Nagarjuna, Vagbhata, Govindacharya, Yashodhar, Ramchandra, Somdev, Acharya Prafulla Chandra Ray, Sir Har Gobind Khorana, Shanti Swarup Bhatnagar, CNR Rao, Raghunath Anant Mashelkar.	**10**

References books:

1. Indian Alchemy or Rasayana by S. Mahdihasan Http://archive.org/details/details/indianalchemyorrasayanabys.mahdihassan/page/n79/mode/2up
2. History of Chemistry in ancient and medieval India Acharya Prafulla Chandra Ray Edited by P Ray Indian Chemical Society, Culcuttta, 1956 page no 208-239
3. India's glorius Scientific Tradition by Suresh Soni
4. Chapter 15 Scienctist of ancient India, http://digital.nios.ac.in/content/223en/CH.15.pdf
5. Some famous Indian Scientists by S Chandrasekhar, http://www.tifr.res.in/~outreach/biographies/scientists.pdf
6. other source Wikipedia http://en.wikipedia.org/wiki/list_of_indian_Scientists

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SBC00023506T

DSC: CHEM/DSC/T/ 350 | Title of Paper: Chemistry of Nano material and Glass.

Total Credits: 02 | Total Contact Hours: 30 Hrs.

University Assessment 30 Mark | Internal Assessment 20 Marks

Learning outcome

- After studying this course, students will be able to:

1. To understand the basic concept and historical development of nano science.
2. To identify different methods used for the Synthesis of nanoparticles.
3. To explain the structure and properties of carbon nanotubes and fullerenes.
4. To understand various applications of nanomaterials.
5. To explain the composition, types and manufacturing process of glass.
6. To understand the industrial applications and recycling aspects of glass materials.

Course Outcomes (COs)

- After completion of the course, students will be able to:

1. Understand the evolution and fundamental concepts of nano science.
2. Apply different synthesis methods used for nanoparticle preparation.
3. Analyze the structure and properties of carbon nanomaterials.
4. Evaluate the physical and chemical properties of nanoparticles.
5. Identify major applications of nanomaterials in modern technology.
6. Understand the structure, types and manufacturing steps of glass.

Understand industrial uses and environmental aspects related to glass production.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	➢ UNIT-- I Nanoscience • Historical overview of nanoscience from ancient times to modern developments. • Discoveries in nanoscience and nanotechnology. □ Preparation of Nanoparticles • Top–down approaches: Lithography, Etching, High energy ball milling. • Bottom–up approaches: sol–gel synthesis, precipitation, co-precipitation, Biological method-plant, Microorganisms. • Properties of nanoparticles. • Biological methods :- Plant extraction & Microorganism.	10

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	□ Carbon Nanotubes. • Structure and properties of carbon nanotubes (CNTs). • Unique characteristics of CNTs. • Synthesis methods. • Applications.	
II	➢ UNIT II – Principle, Instrumentation and Applications. • Characterization Techniques and Applications. (Principle, Instrumentation and Numerical) • XRD • SEM/TEM • UV- Visible Spectroscopy. • Applications	10
III	➢ UNIT III – Glass • Structure, Classification, Manufacture and Application. • Introduction and History. • Composition and structure of glass. • Classification of glasses. • Manufacture of glass. (formation of molten glass, Shaping, annealing, finishing) • Properties of glass (Chemical and physical) • Industrial and domestic applications • Special Glasses: Types and compositions • Coloured glass,safety glass,hard glass,photo sensitive glass and boro silicate glass Reference book • Microscopic Characterizations Techniques by lambert academic Publishing. • Nanotechnology (principle and practice) by Sulabha k. kulkarni. • Fundamental of Nanoparticles (Synthesis, properties, & classification) by Dr. Manoj Kumar Banjare. • An introduction to Nanomaterials & Nanoscience - Asim K Das • The Science of Nanomaterials: Basics and Applications by A. S. A. Ameta. • Atul Thakur · Preeti Thakur · S.M. Paul Khurana Editors Synthesis and Applications of Nanoparticles. • Fundamentals of Nanoparticles: Classifications, Synthesis Methods, Properties and Characterization" by Barhoum and Makhlouf	10

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SBC00023766P

Lab Course

DSC: CHEM/DSC/T/ 376 Title of Paper: Chemistry of Nonmaterial and Glass.

Total Credits: 02 Total Contact Hours: 60 Hrs.

University Assessment 30 Mark Internal Assessment 20 Marks

- Learning Outcomes

After completion of this laboratory course, students will be able to:

- To Understand basic laboratory techniques used in the synthesis of nanomaterials and glass analysis.
- To Synthesize different nanoparticles such as ZnO, Fe_3O_4, Cu, Ag, and TiO_2 using chemical and precipitation methods.
- To Explain the principles of nanomaterial and types synthesis methods such as precipitation, chemical route, and sol-gel auto-combustion.
- To Operate analytical instruments such as UV-Visible spectrophotometer for studying nanoparticle absorption.
- To Interpret IR and XRD data to identify the structure and properties of nanomaterials.
- To Perform analytical tests on glass samples such as hydrolytic resistance, arsenic limit test, and annealing point determination.
- To Record experimental observations and calculate results accurately while following laboratory safety practices.

- Course Outcomes (COs)

After completing this course, students will be able to:

- To Demonstrate laboratory skills required for the synthesis of nanomaterials.
- To Prepare metal and metal oxide nanoparticles using different chemical methods.
- To Characterize nanomaterials using spectroscopic techniques such as UV-Visible spectroscopy.
- To Analyze structural information of nanoparticles using IR and XRD data.
- To Apply basic analytical techniques for testing physical and chemical properties of glass.
- To Evaluate experimental results and calculate yields or other analytical parameters.
- To Follow standard laboratory procedures, safety measures, and scientific reporting in nanomaterial and glass chemistry experiments.

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➢ Practicals

1. To synthesize ZnO nanoparticles.
2. To prepare Fe_3O_4 nanoparticles.
3. To synthesize copper nanoparticles.
4. To synthesize zinc oxide nanoparticles using a chemical route.
5. To synthesize silver nanoparticles.
6. To synthesize of TiO2 using a chemical route.
7. To synthesize $ZnNiFe_3O_4$ by using sol-gel auto-combustion method.
8. A Study UV-Visible absorption of nanoparticles.

Find out structure on the basis of given IR,XRD data/graph of the following Nanoparticles-

9. Zinc oxide.
10. Silver
11. Titanium oxide
12. Gold
13. To determine the hydrolytic resistance of given glass by powdered glass method.
14. To perform limit test for arsenic in glass sample.
15. To determine annealing point of given glass sample.

• Reference book

- A Practical Manual on Nanomaterials and Nanotechnology" by Alexander Shcherbakov and Vladimir Ivanov.
- "Nanotechnology: Principles and Practices" by Sulabha K. Kulkarni.
- Nanoparticle Technology Handbook (Elsevier)
- Nanoparticles: Preparation and Characterization (Maneesha Pande)

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SBC00023516T

DSE: CHEM/DSE/T/ 351 **Title of Paper: Instrumental Method of Chemical Analysis**
Total Credits: 02 **Total Contact Hours: 30 Hrs.**
University Assessment 30 Marks **Internal Assessment 20 Marks**

Learning Objectives of the Course:

1. Introduce the fundamental concepts and principles of instrumental chemical analysis.
2. To study the construction, working, and applications of analytical instruments.
3. To learn electroanalytical techniques and their applications in chemical measurements.
4. To understand calibration methods, accuracy, precision, and error analysis in instrumentation.
5. To gain knowledge of modern analytical techniques used in pharmaceutical, environmental, industrial, and research laboratories.
6. To develop analytical reasoning and problem-solving skills related to chemical analysis.
7. To understand the importance of automation and recent advancements in analytical instrumentation.
8. Create awareness about recent developments and automation in analytical instrumentation.
9. Promote safe handling and proper maintenance of analytical instruments.
10. Strengthen scientific communication and report-writing skills related to analytical data interpretation.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Describe the construction, instrumentation, and applications of spectroscopic, potentiometric, p^H metric, Refractometry, Polarimetry and Flame photometry techniques.
2. Demonstrate knowledge of electroanalytical methods including Refractometry, Polarimetry, potentiometry, p^H metry, and Flame photometry.
3. Evaluate analytical methods based on accuracy, precision, sensitivity, selectivity, and error analysis.
4. Understand the role of instrumental analysis in pharmaceutical, environmental, food, industrial, and research applications.
5. Develop analytical thinking and problem-solving skills related to instrumental chemical analysis.
6. Demonstrate awareness of recent advancements, automation, and safety practices in analytical instrumentation.

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Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Potentiometer & P^H Meter:** **Potentiometer :** Introduction, Determination of pH, Study of Quinhydrone and Glass electrodes and their use in determination of pH, Potentiometric titrations: Classical and analytical methods for locating end points, Acids- Bases titration with suitable example, Redox titration with suitable example, Precipitation titration with suitable example, Basic circuit of direct reading potentiometer, Advantages of potentiometric titrations **P^H Meter:** Introduction, Arrhenius definition of acids and bases, dissociation of acid and bases in aqueous solution, Units to express H^+ ion conc. molar H^+ ion conc. and concept of pH and pH Scale, Electrochemical cell, Def. reference and indicator electrode,, Calomel and silver-silver chloride electrode, glass electrode for pH measurement (composition and structure of glass electrode, membrane potential, boundary potential, asymmetry potential, glass membrane potential, the alkaline error, the acid error).	10
II	**Refractometer & Polarimeter:** **Refractometry** Introduction, Principle, parameters influencing refraction, significance of critical angle during measurements, refractometers, qualitative and quantitative analysis and analytical applications. **Polarimeter** Introduction, Definition, Principle, Optically Active Substances, Specific Rotation, Factors Affecting Rotation , Instrumentation, Components, Types of Polarimeters, Sample Handling, Experimental Procedures, Applications and Safety.	10
III	**Flame photometry** Principle-Instrumentation, interferences in flame photometry. Factor's that influences intensity of emitted radiations of flame photometry, limitations of flame photometry and applications.	10

References books:

1. Basic concepts of analytical chemistry – S.M. Khopkar.
2. Instrumental methods of chemical analysis –Willard, Merit & Dean.
3. Instrumentals methods of chemical analysis – Chatwal & Anand.
4. Instrumental methods of chemical analysis – H.Kaur.

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SBC00023776P

DSE: CHEM/DSE/P/ 377 Title of Paper: Instrumental Method of Chemical Analysis
Total Credits: 02 **Total Contact Hours: 60 Hrs.**
University Assessment 30 Marks **Internal Assessment 20 Marks**

Learning Objectives of the Course:

1. Understand the basic principles of instrumental analysis techniques.
2. Classify analytical instruments based on their working principles.
3. Learn the operation and applications of common analytical instruments.
4. Analyze qualitative and quantitative chemical data accurately.
5. Understand sampling, calibration, and error analysis in chemical measurements.
6. Develop skills in laboratory handling, instrument maintenance, and safety.
7. Evaluate accuracy, precision, sensitivity, and selectivity of analytical methods.
8. Understand recent advancements and automation in analytical instrumentation.

Course Outcomes (COs):

After completion of the course, students will be able to:

1. Understand the fundamental principles, instrumentation, and applications of modern chemical analysis techniques.
2. Operate common analytical instruments and perform qualitative as well as quantitative analysis of chemical substances.
3. Interpret analytical data such as spectra, chromatograms, calibration curves, and electrochemical measurements.
4. Apply electroanalytical techniques including potentiometry, conductometry, and pH measurements in chemical analysis.
5. Evaluate analytical results using concepts of accuracy, precision, sensitivity, selectivity, and error analysis.
6. Demonstrate laboratory skills, instrument handling, calibration, maintenance, and safety procedures.
7. Develop scientific reporting, data interpretation, and problem-solving abilities related to analytical chemistry.

Module	Topics / actual contents of the syllabus	Contact

Prof. Pathan Mohd Arif Ali Khan
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No.		Hours
I	**Potentiometry** 1. Potentiometric titration of strong acid with strong alkali. 2. Potentiometric titration of ferrous ammonium sulphate against standard $K_2Cr_2O_7$/$KMnO_4$ and determination of redox potential of Fe (II), Fe (III) system. 3. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations potentiometerically. **pH – metry** 1. To determine the dissociation constant of monobasic acid (Acetic acid). 2. To determine the dissociation constant of dibasic acid (Malonic acid). 3. pH-metric titration of strong acid vs strong base.	20
II	**Refractometry** 1. To determine the percentage composition of unknown mixture by (i) graphical method and (ii) by composition law (Densities of pure liquids A & B be given). 2. To determine the molar refractivity of methyl acetate & ethyl acetate, and calculate the refraction equivalents of C, H and Cl atom. To determine the molar refractivity of n-hexane and carbon tetrachloride and calculate the refraction equivalents of C, H and Cl atom **Polarimeter** 3. To determine the specific rotation of cane sugar solution using Polarimeter.	20
III	**Flame photometry** 1. Estimation of Na by flame photometry by calibration curve method. 2. Estimation of Na by flame photometry by regression method. 3. Estimation of K by flame photometry by calibration curve method. 4. Estimation of K by flame photometry by regression method. 5. Estimation of Li by flame photometry Calibration curve method. 6. Estimation of Ca by flame photometry Calibration curve method.	20

Reference books:

1) Advanced Physical Chemistry by Grudeep Raj
2) Systematic Experimental Chemistry Practical by S.W. Rajbhoj and Dr. T.K. Chondekar
3) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4) Practical Physical Chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
5) Experiments in Physical Chemistry, J. M. Wilson, K. J. Newcombe, A.R. Denko. R. M. W. Richett (Pergamon Press)
6) Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.).
7) Experimental Physical chemistry, V.D. Athawale, Parul Mathur, New age International Publishers.
8)Textbook on Practical Phemistry by K. S. Mukherjee

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SCC00023506T

CHE/MN/T/350 : **(Advanced Chemistry III) : Theory Course**
Total Credits : 02 Total Contact Hours : 30 Hrs
University Assessment 30 Marks Internal Assessment 20 Marks
Maximum Marks : 50

Learning Objectives of the Course:

1. Explain classification of carbohydrates, structures of monosaccharides.
2. Illustrate concept of anomer, epimer, reducing and non-reducing sugars,
3. To understand concept Mutarotation, Inversion of sugar, reactions of glucose and glyosidic bonds in polyssacharides.
4. Explain classification of amino acids and reactions with various reagents with their significance, peptide bonds.
5. Explain classification of proteins, structure of proteins.
6. To aware students about nomenclature and classification of heterocyclic compounds.
7. To acquaint students about aromaticity, synthesis and reactions of heterocyclic compounds with one hetero atom.
8. To inform students about the condensed heterocycles with their synthesis.

Course Outcomes (COs):

After completion of the course, students will be able to –

1. To understand classification of carbohydrates, structures of monosaccharidesm.
2. Differentiate between anomer, epimer and, reducing and non-reducing sugars
3. To understand Mutarotation, reactions of glucose and glyosidic bonds.
4. Able to understand classification of amino acids and reactions with various reagents with their significance, peptide bonds.
5. To understand the classification of proteins, structure of proteins.
6. To understand the nomenclature and classification of heterocyclic compounds
7. To understand aromaticity, synthesis and reactions of heterocyclic compounds with one hetero atom.
8. Able to understand condensed heterocycles

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Carbohydrates** Introduction, Definition of carbohydrates, General formula and basic structure, Classification of Carbohydrates, Open-chain and cyclic structures of Glucose and Fructose, Concept of anomers, epimers, Reducing and non-reducing sugars, mutarotation and inversion of sugar. Reactions of Glucose	**10 Hrs**

Prof. Pathan Mohd Arif Ali Khan
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Dr. Babasaheb Ambedkar Marathwada
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	with acid, base, phenyl hydrazine, oxidising and reducing agents, Glyosidic bonds. Biological importance of carbohydrates in living organisms.	
II	**c) Amino Acids** Amino acids: classification of amino acids, concept of ampholytes, isoelectric Ph, zwitter ions, titration curves of glycine. Reaction of amino acids with Ninhyrin,Sanger's. Dansyl chloride and Eddman's reagents with their significance. Peptide bond and it's features. **d) Proteins** Classification of proteins based on function, nutrition and composition, Structural organizations of proteins-primary, secondary, tertiary and quaternary structures.	**10 Hrs**
III	**Reagents:** **Oxidizing Reagents:** DMSO/DCC (Pfitzner–Moffatt oxidation), DMSO/Ac_2O (Swern-type oxidation variant), Dess–Martin periodinane (DMP), Jones reagent (CrO_3/H_2SO_4), OsO_4, SeO_2, $KMnO_4$ **Reducing Reagents:** $LiAlH_4$, $NaBH_4$, DIBAL-H, $NaBH_3CN$, Pd/C, Na/NH_3 (Birch reduction) **Other:** **N-Bromosuccinamide (NBS), Diazomethane, Polyphosphoric acid (PPA)** Classification and nomenclature, Molecular Orbital Structure, aromaticity in pyrrole, furan, thiophene and pyridine.	**10 Hrs**

Text / Reference Books:

1.Organic Chemistry by Morrison and Boyd, Print ice hall.
2. Organic Chemistry by L.G. Wade. Print ice hall.
3. Organic Chemistry Vol. I, II, III by S. M. Mukharji, S. P. Sing and R. P. Kapoor
4. Fundamental of organic chemistry by Solomon, John willey
5. A Text book of organic chemistry by Bahl and Bahl.
6. A Text book of organic chemistry by P. L. Soni.
7. Organic Chemistry 05th edition, by: A. K. Pine.
8. Organic Chemistry, by: Solomons Fryhle
10. Organic Chemistry by Francis A. Carey, McGRAW-HILL, INC.
11. Heterocyclic Chemistry by Raj K. Bansal, New Age International
12. Heterocyclic Chemistry by J. A. Joule and K. Mills, Blackwell Science

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SCC00023516T

CHE/MN/T/351 : **(Title of Paper) Advanced Chemistry IV**

Total Credits : 02 Total Contact Hours : 30 Hrs

Summative SEE: 30 Marks Formative CIA : 20 Marks

Learning Objectives of the Course:

1. To distinguish between strong and weak electrolytes and explain their behavior regarding molar conductivity.
2. To study Debye Huckel theory of conductance. Specifically focusing on concepts of ionic atmosphere, relaxation effect and electrophoretic effect.
3. To derive and analyse Debye Huckel Onsager equation , including understanding its validity and limitation in practical applications.
4. To calculate electrochemical parameters like ionic strength, activity and activity coefficient for strong electrolytes solutions.
5. To Apply the Debye Huckel Limiting Law include its derivation and various modification used to describe electrolyte behaviour.
6. Express the concentration of solution components using mole fraction and molality.
7. Describe the effect of solute concentration on various solution properties like vapour pressure, boiling point, freezing point and osmotic pressure.

8 Perform calculations using the mathematical equations that describe this various colligative effect.

9 Describe the process of distillation and its practical application.

10 Explain the process of osmosis and describe how it is applied industrially and in nature.

11 To define and differentiate between ideal and non ideal solution

12 To identify the thermodynamic conditions for an ideal solution.

13 To explain why and how non ideal solution shows positive or negative deviations from Rault's law due to changes in intermolecular interactions.

14 To analyse the graphical representation (vapour pressure vs Composition curves) for both solutions types.

Course Outcomes (COs): After completion of the course, students will be able to:

1. Differentiate between strong and weak electrolyte and explain their molar conductivity variations

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2. Explain the Debye –Huckel theory of conductance, including the specific impacts of the relaxation effect and electrophoretic effect on ionic mobility.
3. Derive and demonstrate the validity of Debye –Huckel – Onsagar equation for strong electrolyte.
4. Calculate critical electrochemical parameters including ionic strength, activity and activity coefficients of electrolytes.
5. Utilize the Debye-Huckel Limiting law to predict the behavior of ions in dilute solutions.
6. Solve complex numerical related to conductivity and ionic interactions.
7. Understand these properties depend solely on the number of solute particles rather than their chemical identity.
8. Learn the four primary colligative properties, relative lowering of vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure.
9. To utilize Rault's law and Vant Hoff's law to calculate the concentration magnitude.
10. To calculate unknown molecular mass or molar mass of a given solute.
11. Explain how electrolyte cause greater changes in colligative properties compared to nonelectrolytes, utilizing the Van't Hoff factor.
12. Understand the distinction between ideal and non-ideal solution based on Raoult's law.
13. Learn how intermolecular forces of attraction dilute solution behaviour.
14. Identify the changes in enthalpy and volume for ideal solution and how they differ for non ideal solutions.
15. Analyse positive and negative deviations from Raoult's law , including the formation of azeotropes.

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	**Electrochemistry** Strong electrolytes, weak electrolytes and molar conductivity, Debye Huckel theory of conductance, Ionic atmosphere, relaxation effect, Electrophoretic effect, Debye Huckel Onsagar equation, validity and derivation of the Debye Huckel Onsagar equation, ionic strength, activity and activity coefficient of the strong electrolyte, Debye Huckel limiting law , Derivation and modification of Debye Huckel limiting law , Numerical	10
II	**Colligative properties of dilute solution:** Introduction, Solution, electrolytes and non electrolytes, Meaning of the term colligative property, relative lowering of vapour pressure of the solvent in solution, elevation in boiling point of solvents in solution, Landsberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hartley method, application of colligative properties to determine molecular weight of nonelectrolyte, abnormal	10

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	molecular weight, Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property, Numerical.	
III	**Potentiometer & P^H Meter:** **Potentiometer :** Introduction, Determination of pH, Study of Quinhydrone and Glass electrodes and their use in determination of pH, Potentiometric titrations: Classical and analytical methods for locating end points, Acids- Bases titration with suitable example, Redox titration with suitable example, Precipitation titration with suitable example, Basic circuit of direct reading potentiometer, Advantages of potentiometric titrations **P^H Meter:** Introduction, Arrhenius definition of acids and bases, dissociation of acid and bases in aqueous solution, Units to express H^+ ion conc. molar H^+ ion conc. and concept of pH and pH Scale, Electrochemical cell, Def. reference and indicator electrode,, Calomel and silver-silver chloride electrode, glass electrode for pH measurement (composition and structure of glass electrode, membrane potential, boundary potential, asymmetry potential, glass membrane potential, the alkaline error, the acid error).	**10**

References books:

1. Physical Chemistry Atkins, P. W. Paula, J. ;Physical Chemistry, Oxford Publication, 11th edition
2. Physical Chemistry – R. A. Alberty, R. I. Billy, John Wiley-1995
3. Physical Chemistry – G. M. Barrow, Tata Mc- Graw Hill-1988
4. Physical Chemistry by Alberty and Silby, Jolly Wiley.
5. Principles of Physical Chemistry by B. R. Puri , L. R. Sharma, M. S. Pathania.
6. Essentials of Physical Chemistry by Bahl Tuli –Revised, S. Chand and Company Ltd.
7. Principles of Physical Chemistry, Fourth Edition by S. H. Marron and C. F. Pruton.
8. Physical Chemistry -4thEdition –Gilbert W. Castellan Narosa.

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SOC00023766P
CHEM/RP/T/376: (Title of Paper) Research Project Total Credits : 04 Total Contact Hours : 120 Hrs Summative SEE: 60 Marks Formative CIA : 40 Marks
OR
SJC00023266P
CHEM/OJT/P/376: (Title of Paper) ON JOB TRAINING Total Credits : 04 Total Contact Hours : 120 Hrs Summative SEE: 60 Marks Formative CIA : 40 Marks

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Guidelines and Evaluation of OJT, Internship Research Project

OJT/ Internship/ Research Project/ Field Project Evaluation:

a) OJT (On Job Training)/ Internship:

i) Each student will be required to prepare a detailed plan within a week of joining the agency for OJT/internship, which will be submitted to concerned Department Advisor.

ii) Each student will be required to maintain the diary in which daily/weekly activities will be recorded. This will be sent to Agency mentor and Department Advisor on weekly basis.

iii) At the end of the OJT / Internship the student will prepare a write up on achievement of the goals mentioned in the detailed plan.

iv) At the end of the OJT / internship student will submit a report in about 15 to 20 pages.

Formative Continuous Internal Assessment (CIA) of OJT / Internship:

The CIA of OJT shall be conducted by the university department/ affiliated college for 40% of the maximum marks allotted for course. Two CIA, each of 20% marks shall be conducted at different phases, First, CIA after 10-15 days and Second CIA after 25-30 days of summer break.

The outline of distribution of marks for continuous assessment for O.TT work shall be as under.

Table : Distribution of marks for continuous internal assessment for OJT work

Sr. No.	Particulars	Week: 10-15 days of Summer break	CIA (TI) Week :25-30 days of Summer break	Total Marks
1	Plan of OJT/internship including goal of internship	10 Marks	--	10 Marks
2	First 10- 15 days report of the activity with Presentation	05 Marks	----	05 Marks
3	Second 25-30 days report of the activity with Presentation		05 Marks	05 Marks
4	Progress (written) Report of OJT/Internship with Presentation	--	10 Marks	10 Marks
5	Presentation and viva	--	10 Marks	10 Marks
	Total	15 Marks	25 Marks	40 Marks

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Semester End Examination: Assessment of OJT / Internship:

Semester-end examination shall be conducted by university in the 5th week of the summer break for 60 % of the 1naximum marks allotted for the course. The examination shall be jointly done by two examiners, one from the same college/ university department as internal examiner and other from other college or university department or industry organization appointed by university as external examiner.

Criteria for External (Semester End Examination) Assessment: (60 marks)-

General Assessment: (15 marks)

i) **Punctuality:** Consistently attends work on all scheduled days, arrives promptly, and remains committed to co1npleting the required hours.

ii) **Sincerity:** Demonstrates dedication by diligently meeting the organization's quality standards and exhibits a willingness to exert additional effort to accomplish assigned tasks effectively.

iii) **Initiative:** Exhibits a proactive approach by exploring innovative methods for task execution, identifies obstacles, and persistently slTives to overcome challenges.

iv) **Commitment:** Sets clear work-related objectives, prioritizing client/customer satisfaction, possesses a comprehensive understanding of job duties, and consistently delivers optimal performance.

v) **Attitude towards profession:** Assumes accountability for personal actions, proactively engages in self-improvement through continuous learning, emb,·aces new concepts and challenges, welcomes constructive feedback, upholds trustworthiness and confidentiality, treats individuals from all backgrounds with respect, maintains appropriate attire, and consistently arrives prepared for work.

Skills: (25 marks)

i) **Communication:** Demonstrates proficient written and verbal communication skills while exhibiting good manners and etiquette in interactions.

ii) **Documentation:** Proficiently prepares relevant documents

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and maintains systen1atic organization of records.

iii) **Reporting:** Effectively communicates work progress and accomplishments to higher authorities within the organization in a timely and approptiate manner.

iv) **Achievement of Goals:** Each undergraduate program outlines specific skills and abilities to be acquired upon completion. These objectives should be incorporated and en1phasized here to track and ensure the attainment of prograrmnatic goals

Written report of OJT / Internship: (10 marks) Presentation and Viva-voce: (10 marks)

EVALUATION REPORT OF OJT / INTERNSHIP
(To be filled by Internal and External Examiners)

Name of University Dept. / College _ Code _____ __
Degree/ Programme _____ Semester ____ Seat No. _____
__ Name of the candidate _____ __

Specialization / Subject _____ __
Name and Place of OJT /Internship _____
Title ofOJT / internship project. _____ __

Table VI : Evaluation Scheme/ Marking Scheme (60 Marks)

SL No	Type of **Evaluation**	Criteria for Evaluation	Marks Obtained		Total Average
			Internal Examiner	External Examiner	
L	**General and Skill Assessment (40)**	**A) General Assessment(15)**			
		I) Punctuality(3)			
		2) Sincerity (3)			
		3) Initiative (3)			
		4) Commitment (3)			
		5) Attitude (3)			
		B) Skills (25)			
		I.) Communication (S)			
		2) Documentation			

		(5)			
		3) Reporting (5)			
		4) Achievement (10) of Goal			
2	**Written Report and Presentation (20)**	1) Written Report of OJT/ Internship (10)			
		2) Presentation and Viva-voce *(10)*			
		Total			

Date:
Place:
(Name and Signature)
Internal Examiner

Date:
Place:
(Name and Signature)
External Examiner

b)Research Project:

i) Every university department/ affiliated college will set up a research team with 3 to 4 members
ii) At the start of each semester, the research team will assign a mentor to each student.
iii) With the mentor's help, student will create a proposal and get it approved by the university department/ affiliated college.
iv) When research work is completed, student will have to submit a report of 25-30 pages.
v) Report should follow the same structure and formatting rules similar **to** thesis.
vi) Throughout the semester, progress of the students will be assessed, and exams will have two parts.

Formative Continuous Internal Assessment (CIA) of Research Project:

The CIA will be conducted by the university department/ affiliated college for 40% of the maximum 111arks al lotted for course in the semester.

Criteria for Continuous Internal Assessment (CIA): (40)

The university department/ affiliated college shall conduct two CIA examinations, each of 20 marks. First CIA shall be conducted after completion of one month and second CIA shall be conducted after completion of two months of the concerned semester.

The outline of distribution of marks for continuous assessment activity for CIA-1 and CIA-2 of a 1·esearch project work shall be as under.

Table VII: Evaluation Scheme/ Marking Scheme for CIA (40 Marks)

Sr. No	Particulars	After One month (First **CJA)**	After **two** month (Second ClA)	Total Marks
	A) Research proposal	**(12 Marks)**	--	
	])State111enl of Research Problem	2 Marks	---	2 Marks
	2) Research Design	2 Marks	--	2 Marks
	3) Review of Literature	2Marks	---	2 Marks
	4) Hypothesis	2 Marks	---	2 Marks

Prof. Pathan Mohd Arif Ali Khan
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Dr. Babasaheb Ambedkar Marathwada
Chh.Sambhajinagar (M.S)

	5) Objectives and Met11odology	2 Marks	---	2 Marks
	6) Expected Outcome (Social relevance, local ./ regional needs, national requirements and international impo11ance	2 Marks	--	2 Marks
	B) Presentation and Viva Voce	**8 Marks**	--	**8 Marks**
2	I) Written Progress of the Work Done	----	10 Marks	10 Marks
	2) Presentation and Viva-Voce	------	10 Marks	10 Marks
	Total	20 Marks	20 Marks	40 Marks

Summative (Semester-end) examination (SEE) of Research Project:

Semester end examination shall be conducted by the university at the end of semester for 60% of the maximum marks allotted for course.

The semester end examination of research project work shall be conducted before the commencement of theory examination at the concerned university department/affiliated colleges by two examiners, one fr01n the sa1ne college as internal examiner and other from other colleges/university department/industry appointed by university as external examiner. There may be two external examiners but not two internal examiners for conducting the examination. A pair of examiners shall conduct examinations for two batches per day having a maximum of 12 students in each batch.

The outline of the distribution of marks for semester end examination shall be as under.

Criteria for Semester End Examination / Assessment: (60 Marks) General assessment: (10 Marks)

i) Punctuality : 02 Marks
ii) Sincerity : 02 Marks
iii) Perseverance: 02 Marks
iv) Commitment: 02 Marks
v) Attitude : 02 Marks

Skills: (20 **Marks)**

i) Library/reference work: 05 Marks

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ii) Use of JCT in research : 05 Mad s
iii) Communication : 05 Marks
iv)Paper publication (Paper published m National / International Conference Proceedings/ UGC CARE list Journals / SCI /SCOPUS / Web of Science Indexed Journals): 05 Marks

Research project report: 20 marks

Presentation and viva-voce: 10 marks

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QUESTION PAPER PATTERN

DSC: CHE/DSC/P/ 326 **Title of Paper: Inorganic Chemistry**

Total Credits: 02 Total Contact Hours: 30 Hrs.

University Assessment: 30 Marks Internal Assessment: 20 Marks

	University Question Paper	
Question No	Title of the questions	Marks
1.	To detect two acidic and two basic radical from given mixture. OR any one from the following 1. Preparation of Potash Alum, $K_2SO_4.Al_2(SO_4)_3.24H_2O$ 2. Preparation of Ferrous ammonium sulphate, $FeSO_4(NH_4)_2SO_4.6H_2O$ 3. Preparation of Ferrous Oxalate, $FeC_2O_4.2H_2O$ 6. Preparation of Potassium trioxalate Ferrate, $K_3[Fe(C_2O_4)_3].3H_2O$ 4. Nickel Ammonium Sulphate, $NiSO_4.(NH_4)_2.SO_4.6H_2O$	10
2	**Seperation and estimation of any one metal ion by gravimetry or volumetry from binary Mixture** 1. Fe^{2+} and Al^{3+} 2. Ca^{2+} and Ba^{2+} 3. Fe^{2+} and Zn^{2+} 4. Cu^{2+} and Ni^{2+} 5. Cu^{2+} and Ba^{2+}	15
3	Record Book & Viva - Voce	05

Practical question paper
SAC00023275P

CHE/DSC/P/327: **Title of Paper: Spectral Analysis**

Lab Course:

University Assessment 30 Marks

Module No	Topics / actual contents of the syllabus	Marks
I	**Solve any from the following** 1. Nitration of phenol or substituted phenols using $CaNO_3$. 2. Green synthesis of benzhydrol from benzophenone. 3. Green synthesis of acetanilide from aniline using Zn / acetic acid. 4. Preparation of 1, 4- dihydropyrimidinone from ethyl acetoacetate, benzaldehyde and urea using oxalic acid as catalyst. 5. Preparation of β-naphthyl methyl ether from β-naphthol. (Methylation by DMs, NaOH) 6. Preparation of 4-methyl-7-hydroxy coumarin from resorcinol.	**13**

Prof. Pathan Mohd Arif Ali Khan
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University, Chh.Sambhajinagar (M.S)

	7. Preparation of Hippuric acid from Glycine.	
II	**Interpretation of IR and NMR spectra any one** Determination of structure of organic compound from given IR, NMR spectra. (Ethyl alcohol, Cis-2-butene, Trans-2-butene, Benzoic acid, Propanaldehyde, Ethyl methyl ether, 1 Butyne, Ethyl acetate, Propyl Cyanide, Salicylic Acid, Nitro phenols, Isopropyl benzene, Propanamine, Benzamide, n-Pentane, 2-chloro butane, Acetophenone)	**12**
III	**Record viva Voce**	**05**

QUESTION PAPER PATTERN

DSC: SUB/DSC/P/ 376 **Title of Paper: Organic Chemistry Practical**
Total Credits: 02 Total Contact Hours: 30 Hrs.
University Assessment 30 Marks Internal Assessment 20 Marks

	University Question Paper	
Question No	Title of the questions	Marks
1.	Separate given mixture of by paper chromatography /TLC. a) sugars/amino acids OR Determine quantitatively the amount of the given organic compound b) Estimation of	10
2.	Carry out the assigned organic preparation of ..... From---------- monitor the progress of the reaction by thin layer chromatography and report the yield, melting point of the product.	15
4.	Record Book/ Viva Voce	05

QUESTION PAPER PATTERN

DSC: SUB/DSC/P/ 377 **Title of Paper: Physical Chemistry**
Total Credits: 02 **Hours: 4 Hrs.**
University Assessment 30 Marks **Internal Assessment 20 Marks**

University Question Paper		
Question No	**Title of the questions**	**Marks**

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1	**Instrumental Experiments (Any one)** **Refractometry** 1. To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C. 2. Determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution **Colorimetry** 1. To determine equilibrium quotient for the formation of monothiocynato iron (III) complex by colorimetric measurement. 2. Determine the concentration of Cu^{2+} ion in given solution titrating with EDTA solution by colorimetric measurement. **pH -metry** 1.To determine pKa values of the given organic acid by pH measurements. 2. To determine the dissociation constant of dibasic acid (Oxalic acid). 3.To determine the proton -ligand stability constant of an organic acid and the metal ligand stability constant of it's complex by p^H measurements. **Conductometry** 1. Titration of oxalic acid with strong alkali solution. 2. Titration of a mixture of weak acid and strong acid with strong alkali. 3. To determine concentration of sodium acetate solution by titrating it conducto metrically with standard HCl solution. **Potentiometry** 1. Potentiometric titration of a strong acid (HCl) with a weak base(NH_4OH) 2.Determination of the composition of a mixture of acids (HCl and CH_3COOH) mixture with NaOH **Polarimetry** 1. Determination of concentration of a given solution of an optically active substance (say cane sugar) by polarimetric measurements. 3. To study the inversion of cane sugar by polarimeter.	15
2	**Non instrumental Experiments (Any one)** 1. To determine the surface tension of a liquid by stalagmometer method. 2. To study the effect of surfactants on surface tension of water by using stalagmometer . 3. To Determination of partition coefficient of iodine between water and carbon tetrachloride. 4. Determine the solubility of benzoic acid in water at different temperature and hence its heat of solutions . 5. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of 0.5 N H_2SO_4. 6. To Study the effect of addition of an electrolyte (NaCl or KCl or Na_2SO_4) on the solubility of monobasic organic acid (benzoic acid) at room temperature. 7. Determination of interfacial tension between two immiscible liquids say benzene and water at room temperature. 8. To investigate the kinetics of iodination of acetone. 9.Determine rate constant of the reaction between $K_2S_2O_8$ and KI having equal concentration of the reaction species. (a=b). 10. Investigate reaction between Hydrogen peroxide and potassium iodide kinetically.	10

Prof. Pathan Mohd Arif Ali Khan
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University, Chh.Sambhajinagar (M.S)

	11.To investigate the influence of ionic strength on the rate constant between potassium persulphate and potassium iodide.	
3	Record Book & Viva - Voce	**05**

QUESTION PAPER PATTERN		
DSE: CHE/DSE/P/ 377	**Title of Paper: Instrumental Method of Chemical Analysis**	
Total Credits: 02	**Total Contact Hours: 30 Hrs.**	
University Assessment 30 Marks	**Internal Assessment 20 Marks**	
University Question Paper		
Question No	Title of the questions	Marks
1	**Any One from the following** 1. Potentiometric titration of strong acid with strong alkali. 2. Potentiometric titration of ferrous ammonium sulphate against standard $K_2Cr_2O_7$/$KMnO_4$ and determination of redox potential of Fe (II), Fe (III) system. 3. Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations potentiometerically. 4. To determine the dissociation constant of monobasic acid (Acetic acid). 5. To determine the dissociation constant of dibasic acid (Malonic acid). 6. pH-metric titration of strong acid vs strong base.	15
2	**Any One from the following** 7. To determine the percentage composition of unknown mixture by (i) graphical method and (ii) by composition law (Densities of pure liquids A & B be given). 8. To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction equivalents of C, H and Cl atom. 9. To determine the specific rotation of cane sugar solution using Polarimeter. 10. Estimation of Na by flame photometry by calibration curve method. 11. Estimation of Na by flame photometry by regression method. 12. Estimation of K by flame photometry by calibration curve method. 13. Estimation of K by flame photometry by regression method. 14. Estimation of Li by flame photometry Calibration curve method. 15. Estimation of Ca by flame photometry Calibration curve method.	10
3	Record Book & Viva - Voce	05

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QUESTION PAPER PATTERN
CHEM/VSC/P/326: (Title of Paper) Dyes Chemistry

Total Credits : 02 Time in Hours : 03.00 Hrs
Summative SEE: 30 Marks Formative CIA : 20 Marks

Question No	Title of the question paper	Marks
1	**Conduct ONE experiment among the following** 1. Preparation of Azo Dye by diazotization (e.g., Aniline → Orange dye) 2. Synthesis of Methyl Orange indicator 3. Preparation of Methyl Red 4. Synthesis of Crystal Violet dye 5. Preparation of Malachite Green dye	15
2	**Perform any ONE from among the following** 1. Synthesis of Phenolphthalein indicator 2. Preparation of Fluorescein dye 3. Dyeing of cotton fabric using direct dyes 4. Dyeing of wool/silk using acid dyes 5. Study of fastness properties of dyes (washing, light, heat)	10
3	Record Book and Viva-Voce	5

QUESTION PAPER PATTERN
CHEM/VSC/P/327: (Title of Paper) Drug Chemistry
Lab Course -____

Total Credits : 02 Time in Hours : 03.00 Hrs
Summative SEE: 30 Marks Formative CIA : 20 Marks

Question No	Title of the question paper	Marks
1	**Conduct ONE experiment among the following** 1. Preparation of Aspirin 2. Synthesis of Paracetamol 3. Preparation of Benzocaine 4. Synthesis of Sulfanilamide 5. Preparation of Barbituric Acid	15
2	**Perform any ONE from among the following**	10

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	1. Preparation of Iodoform 2. Estimation of Aspirin by titration 3. Estimation of Paracetamol using spectrophotometry 4. Identification of functional groups in common drugs 5. Study of antimicrobial activity of selected drugs	
3	Record Book and Viva-Voce	**5**

Chromatographic

DSE: CHE/DSE/P/ 326
Total Credits: 02
Internal Assessment 20 Marks

Title of Paper: Lab Course
University Assessment 30 Marks
BSc- V Semester (Chemistry)

Question No.	Title of the questions	Marks
1.	**Perform any one from the following.** 7. To extract pigments from a medicinal plant. 8. To separate a mixture of plant pigments by batch process. 9. To determine the ion-exchange capacity of Amberlite resin. 10. To separate a mixture of an aldehyde and a carboxylic acid using column chromatography. 11. To separate and identify given amino acids using ascending paper chromatography and calculate their R_f values. 12. To separate sugars using thin layer chromatography (TLC) and determine their R_f values.	10
2.	**Perform any one from the following.** 1. To purify water using cation and anion exchange resins. 2. To perform paper chromatography on different black ink samples and calculate the Rf values of their components. 3. To separate and identify monosaccharides present in a given mixture using paper chromatography. 4. To check the purity of given API (Rifampicin) by TLC. 5. Separation and identification of metal ions Ni and Cr by paper chromatography. 6. Separation and identification of metal ions Ni and Cu by paper chromatography.	15
3.	**Record book and Viva**	05

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