Date :- 25/04/2025

NOTIFICATION

Sub :- CBCS Syllabi of B. Sc. in Chemistry (Sem. V & VI)

Ref. :- Decision of the Academic Council at its meeting held on 22/04/2025.

The Syllabi of B. Sc. in Chemistry (Fifth and Sixth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2023 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2025-26.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon-425001

KNOWLEDGE IS POWER

ESTD. 1945

STRUCTURE AND SYLLABUS

B.Sc. Honours/Honours with Research (T.Y. B.Sc. Chemistry)

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. Academic Year: 2025-26]

Preface

The core objective of Khandesh College Education Society's is to prepare their students for the society. The Moolji Jaitha College (Autonomous), Jalgaon, envisions all its programmes in the best interest of their students and in this endeavour; it offers a new vision to all its Under-Graduate courses. It imbibes the guidelines of UGC, NEP-2020 and the Government of Maharashtra for all its Under Graduate programmes. The Board of Study in Chemistry of the college prepared the syllabus for the first year undergraduate of Chemistry. The new curriculum of B. Sc. (Three Year Bachelor's Degree) Chemistry and B. Sc. (Four Year Bachelor's Degree – Honours / Honours with Research) Chemistry offer courses in the areas of Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Polymer Chemistry, Industrial Chemistry, Green Chemistry, Nanoscience and Nanotechnology etc. All the courses are having defined objectives and learning outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offer ample skills to pursue research as career in the field of chemistry and allied areas.

Hence, Board of Studies in Chemistry in its meeting held on 22/03/2025 resolved to accept the revised syllabus for T. Y. B. Sc. (Chemistry) based on Choice Based Credit System (CBCS) of UGC, NEP-2020 and the Government of Maharashtra guidelines.

Program Outcomes (PO) for B.Sc. Program:

Program outcomes associated with a B.Sc. degree are as follows:

PO No.	PO
1	Graduates should have a comprehensive knowledge and understanding of the fundamental principles, theories, and concepts in their chosen field of study.
2	Graduates should possess the necessary technical skills and competencies related to their discipline, including laboratory techniques and data analysis.
3	Graduates should be able to identify, analyze, and solve complex problems using logical and critical thinking skills. They should be able to apply scientific methods and principles to investigate and find solutions.
4	Graduates should be proficient in effectively communicating scientific information, both orally and in writing.
5	Graduates should have a basic foundation in research methods and be capable of designing and conducting scientific investigations.
6	Graduates should be able to work effectively as part of a team, demonstrating the ability to collaborate with others, respect diverse perspectives, and contribute to group projects.
7	Graduates should recognize the importance of ongoing learning and professional development. They should be equipped with the skills and motivation to engage in continuous learning, adapt to new technologies and advancements in their field, and stay updated with current research.

Program Specific Outcome PSO (B.Sc. Chemistry):

After completion of this course, students are expected to learn/understand the following:

1	Fundamental concepts of thermochemistry, knowledge about gaseous state and electrolytic dissociation.
2	Students will also learn practical aspects of organic chemistry specially functional groups.
3	Various topics of inorganic chemistry which will be a base to improve their career in the area of inorganic chemistry. Student will learn various theories of inorganic chemistry and their application to define coordination complexes.
4	Prepare derivatives of simple organic compounds, water and soil quality parameters through physical and chemical analysis.

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	**Qualification Title**	**Credit Requirements**		**Semester**	**Year**
		Minimum	**Maximum**		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

Credit distribution structure for Three/ Four year Honours/ Honours with Research Degree Programme with Multiple Entry and Exit

F.Y. B.Sc.

Year (Level)	**Sem**	**Subject-I (M-1)**	**Subject-II (M-2)**	**Subject-III (M-3)**	**Open Elective (OE)**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT, RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
I (4.5)	I	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	OE-1(2T)	---	AEC-1(2T) (Eng) VEC-1(2T) (ES) IKS(2T)	CC-1(2T)	22	**UG Certificate**
	II	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	OE-2(2T) OE-3(2P)	---	AEC-2(2T) (Eng) VEC-2(2T) (CI)	CC-2(2T)	22	
	Cum. Cr.	**8**	**8**	**8**	**6**	**---**	**10**	**4**	**44**	
Exit option: Award of UG Certificate with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor.										

S.Y. B.Sc.

Year (Level)	**Sem**	**Subject-I (M-1) Major***		**Subject-II (M-2) Minor #**	**Subject-III (M-3)**	**Open Elective (OE)**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**CC, FP, CEP, OJT/Int/RP**	**Cumulative Credits/Sem**	**Degree/ Cumulative Credit**
		Mandatory (DSC)	**Elective (DSE)**	**(MIN)**							
2 (5.0)	III	DSC-5(2T) DSC-6(2T) DSC-7(2P)	---	MIN-1(2T) MIN-2(2T) MIN-3(2P)	---	OE-4(2T)	SEC-1(2T)	AEC-3(2T) (MIL)	CC-3(2T) CEP(2)	22	**UG Diploma**
	IV	DSC-8(2T) DSC-9(2T) DSC-10(2P)	---	MIN-4(2T) MIN-5(2P)	---	OE-5(2T)	SEC-2(2T) SEC-3(2P)	AEC-4(2T) (MIL)	CC-4(2T) ۞ FP(2)	22	
	Cum. Cr.	**12**	**---**	**10**	**---**	**4**	**6**	**4**	**8**	**44**	
	Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major & Minor.										

***** Student must choose one subject as a Major subject out of M-1, M-2 and M-3 that he/she has chosen at First year
# Student must choose one subject as a Minor subject out of M-1, M-2 and M-3 that he/she has chosen at First year (Minor must be other than Major)
۞ OJT/Internship/CEP should be completed in the summer vacation after 4th semester

T.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1) Major		Subject-II (M-2) Minor	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	Elective (DSE)	(MIN)							
3 (5.5)	V	DSC-11(2T) DSC-12(2T) DSC-13(2T) DSC-14(2P) DSC-15(2P)	DSE-1A/B (2T) DSE-2A/B (2P)	---	---	---	VSC-1(2T) VSC-2(2P)	---	OJT/Int (4)	22	**UG Degree**
	VI	DSC-16(2T) DSC-17(2T) DSC-18(2T) DSC-19(2T) DSC-20(2T) IKS DSC-21(2P) DSC-22(2P)	DSE-3A/B (2T) DSE-4A/B (2P)	---	---	---	VSC-3(2T) VSC-4(2P)	---	---	22	
	Cum. Cr.	**24**	**8**	---	---	---	**8**	---	**4**	**44**	
	Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										

Fourth Year B.Sc. (Honours)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-25(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	---	22	**UG Honours Degree**
	VIII	DSC-27(4T) DSC-28(4T) DSC-29(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	OJT/Int (4)	22	
	Cum. Cr.	**28**	**8**	**4**	**---**	**---**	**---**	**4**	**44**	
Four Year UG Honours Degree in Major and Minor with 176 credits										

Fourth Year B.Sc. (Honours with Research)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	RP(4)	22	**UG Honours with Research Degree**
	VIII	DSC-27(4T) DSC-28(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	RP(8)	22	
	Cum. Cr.	**20**	**8**	**4**	**---**	**---**	**---**	**12**	**44**	
Four Year UG Honours with Research Degree in Major and Minor with 176 credits										

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **OE/GE**- Open/Generic elective, **VSC**- Vocational Skill Course, **SEC**- Skill Enhancement Course, **VSEC**- Vocation and Skill Enhancement Course, **AEC**- Ability Enhancement Course, **IKS**- Indian Knowledge System, **VEC**- Value Education Course, **T**- Theory, **P**- Practical, **CC**-Co-curricular **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project, **CEP**- Community Extension Programme, **ENG**- English, **CI**- Constitution of India, **MIL**- Modern Indian Laguage

- Number in bracket indicate credit
- The courses which do not have practical 'P' will be treated as theory 'T'
- If student select subject other than faculty in the subjects M-1, M-2 and M-3, then that subject will be treated as Minor subject, and cannot be selected as Major at second year.

Details of T.Y. B.Sc. (Chemistry)

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
Semester V, Level – 5.5											
DSC-11	DSC	CHE-DSC-351	Principles of Physical Chemistry	2	2	---	2	20	---	30	---
DSC-12	DSC	CHE-DSC-352	Coordination Chemistry	2	2	---	2	20	---	30	---
DSC-13	DSC	CHE-DSC-353	Organic Chemistry	2	2	---	2	20	---	30	---
DSC-14	DSC	CHE-DSC-354	Practical on Physical Chemistry-I	2	---	4	4	---	20	---	30
DSC-15	DSC	CHE-DSC-355	Practical on Inorganic Chemistry-I	2	---	4	4	---	20	---	30
DSE-1A	DSE	CHE-DSE-351A	Introduction to Analytical Chemistry	2	2	---	2	20	---	30	---
DSE-1B	DSE	CHE-DSE-351B	Pharmaceutical Chemistry	2	2	---	2	20	---	30	---
DSE-2A	DSE	CHE-DSE-352A	Practical on Organic Chemistry -I	2	---	4	4	---	20	---	30
DSE-2B	DSE	CHE-DSE-352B	Practical on Analytical Chemistry-I	2	---	4	4	---	20	---	30
VSC-1	VSC	CHE-VSC-351	Green Chemistry	2	2	---	2	20	---	30	---
VSC-2	VSC	CHE-VSC-352	Practical on Green Chemistry	2	---	4	4	---	20	---	30
OJT/Int	OJT	CHE-OJT-351	On Job Training /Internship	4	---	8	8	---	40	---	60
Semester VI, Level – 5.5											
DSC-16	DSC	CHE-DSC-361	Concepts in Physical Chemistry	2	2	---	2	20	---	30	---
DSC-17	DSC	CHE-DSC-362	Advanced Inorganic Chemistry	2	2	---	2	20	---	30	---
DSC-18	DSC	CHE-DSC-363	Organic Spectroscopic Methods	2	2	---	2	20	---	30	---
DSC-19	DSC	CHE-DSC-364	Chemistry of Polymers	2	2	---	2	20	---	30	---
DSC-20	DSC/IKS	CHE-DSC-365	Chemistry in Ancient India	2	2	---	2	20	---	30	---
DSC-21	DSC	CHE-DSC-366	Practical on Physical Chemistry-II	2	---	4	4	---	20	---	30
DSC-22	DSC	CHE-DSC-367	Practical on Inorganic Chemistry-II	2	---	4	4	---	20	---	30
DSE-3A	DSE	CHE-DSE-361A	Introduction to Analytical Instrumentations	2	2	---	2	20	---	30	---
DSE-3B	DSE	CHE-DSE-361B	Industrial Inorganic Chemistry*	2	2	---	2	20	---	30	---
DSE-4A	DSE	CHE-DSE-362A	Practical on Organic Chemistry -II	2	---	4	4	---	20	---	30
DSE-4B	DSE	CHE-DSE-362B	Practical on Analytical Chemistry-II	2	---	4	4	---	20	---	30
VSC-3	VSC	CHE-VSC-361	Aspects of Industrial Chemistry	2	2	---	2	20	---	30	---
VSC-4	VSC	CHE-VSC-362	Practical on Industrial Chemistry	2	---	4	4	---	20	---	30

*NPTEL course

Examination Pattern

Theory Question Paper Pattern:

- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions: Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. The tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
    - Q 2 and Q3 Attempt any 3 out of 4 sub-question; each 4 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT. The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations. The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- Practical examination shall be conducted for 2 consecutive days for 2 hr/ day where incubation conditionis required.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

SEMESTER-V

T.Y. B.Sc. Chemistry (Major)
Semester-V
CHE-DSC-351: Principles of Physical Chemistry

Total Hours: 30 **Credits: 2**

Course objectives	▪ To acquire the knowledge about chemical kinetics. ▪ To learn the significance of phase equilibria and phase rule. ▪ To learn fundamental and advanced concepts of nuclear chemistry. ▪ To evoke the important concepts of electrochemistry.	
Course outcomes	After successful completion of this course, students are expected to: ▪ understand the concepts of integrated rate equations and effect of temperature on reaction rate. ▪ understand the importance of phase rule and its applications. ▪ understand the concept of radioactivity, radioactive decay and nuclear reactions. ▪ understand the electrochemistry of different types of concentration cells.	
Unit	**Contents**	**Hours**
Unit I	**Chemical Kinetics** Introduction, Derivation of integrated rate equations for zero, first, second and third order reaction, Order of a reaction, Different methods to determine the order of a reaction (integrated rate equations, graphical, half-life and differential method), Effect of temperature on reaction rate: Arrhenius equation, Related numericals.	**8**
Unit II	**Phase Equilibria** Introduction, Concept of phase, component and degrees of freedom of a system with suitable examples, Derivation of phase rule, One component system, Phase diagrams of one-component system: Water system and Sulphur system, Related numericals.	**8**
Unit III	**Nuclear Chemistry** Introduction, Radioactivity and its unit, Types of radioactive radiations (alpha, beta and gamma rays) and their properties, Types of radioactive decay: alpha and beta decay, Rate of radioactive decay, Half-life of a radioactive isotope, Activity of a radioactive substance, Calculation of Half-life of a radioactive isotope, Calculation of sample left after time t, Average	**7**

	life, Nuclear reactions, Nuclear fission and fusion reactions, Related numericals.	
Unit IV	**Electrochemistry** Introduction, Concentration cells, Types of concentration cells: Electrode-concentration cells and Electrolyte-concentration cells, Types of electrolyte-concentration cells: Concentration cells without transference and Concentration cells with transference, Liquid junction potential, Fuel cells: Hydrogen-Oxygen fuel cells, Related numericals.	**7**
Study References	▪ Maron, S. H., and Prutton, C. F. (2012). Principles of Physical Chemistry (4th Edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. ▪ Bahl, B. S., Bahl, A., and Tuli, G. D. (2005). Essentials of Physical Chemistry, S. Chand and Co Ltd., New Delhi. ▪ Puri, B. R., Sharma, L. R., and Pathania, M. S. (2007). Principles of Physical Chemistry (42nd Edition), Vishal Publishing Co., Jalandhar. ▪ Atkins, P. W. (1998). Physical Chemistry, ELBS. ▪ Barrow, G. M. (2003). Physical Chemistry, International Student Edition. ▪ Moore, W. J. (1998). Physical Chemistry, Orient Longman. ▪ McQuarrie, D. A., and Simon, J. D. (2006). Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi. ▪ Laidler, K. J. (1985). Chemical Kinetics, McGraw Hill. ▪ Agrawal, G. L. (1990). Basic Chemical Kinetics, Tata McGraw-Hill Publishing Company Lid., New Delhi. ▪ Moore, J. W., Pearson, R. G. (1981). Kinetics and Mechanism, Wiley. ▪ Arnikar, H. J. (1995). Essentials of Nuclear Chemistry, New Age Publication Ltd. ▪ Friedlander, G., Kennedy, J. W., Macias, E. S., and Miller, J. M., (1981). Nuclear and Radiochemistry, John-Wiley. ▪ Harwey, B. G. (1963). Introduction to Nuclear Physics and Chemistry, Prentice Hall. ▪ Glasstone, S. (1967). Sourcebook of Atomic Energy, Van Nostrand, East-West.	

T.Y. B.Sc. Chemistry (Major)
Semester-V
CHE-DSC-352: Coordination Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To study of bonding in simple molecules by Valence Shell Electron Pair Repulsion theory (VSEPRT). ▪ To acquire the knowledge of coordination chemistry by Valance Bond Theory (VBT). ▪ To understand the structure of coordination compounds using Crystal Field Theory (CFT). ▪ To know the basics of Molecular Orbital Theory (MOT).	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand the bonding and structure of molecules using Valence Shell Electron Pair Repulsion (VSEPR)Theory. ▪ learn coordination chemistry by Valance Bond Theory (VBT). ▪ know the structure of coordination compounds using Crystal Field Theory (CFT). ▪ understand the basics of Molecular Orbital Theory (MOT).	
Unit	**Contents**	**Hours**
Unit I	**Valence Shell Electron Pair Repulsion theory (VSEPRT)** An overview of chemical reactivity. Sidgwick-Powell theory, Valence Shell Electron Pair Repulsion(VSEPR) Theory, Assumption of VSEPRT, Geometry and Shapes of molecules, Effect of lone pairs and electronegativity on bond angle, Isoelectronic principle, Examples using VSEPRT; Simple molecules containing bond pairs of electrons only: Methane (CH_4), Beryllium fluoride (BeF_2), Phosphorus pentachloride (PCl_5), Molecules and ions containing lone and bond pairs of electrons: Ammonia (NH_3), Water (H_2O), Sulphur tetrafluoride (SF_4), Bromine trifluoride (BrF_3), Dichloroiodate (I) anion (ICl_2^-), Pentaflurotellurate (IV) anion (TeF_5^-), Tetrachloroiodate (I) anion (ICl_4^-), Phosphorous trihalides (PX_3), Carbonyl fluorides (OCF_2), Summary of VSEPRT, Drawbacks of VSEPRTheory.	**8**
Unit II	**Valance Bond Theory (VBT)** Valance Bond Theory (VBT), assumptions of VBT, shortcoming of VBT, Examples of square planar, Tetrahedral and octahedral complexes:	**6**

	Tetracyanonickelate(II) ion, $[Ni(CN)_4)]^{2-}$, Tetrachloronickelate (II) ion $[NiCl_4]^{2-}$, Tetrammine copper (II) ion $[Co(NH_3)_4)]^{3+}$ and Cobalt(III) hexaamminecobalt(III) ion, $[Co(NH_3)_6)]^{3+}$. Inner and outer d-orbital octahedral complexes.	
Unit III	**Crystal Field Theory (CFT)** Crystal Field Theory (CFT), Assumptions of CFT, Orientation of d-orbitals and CFT of energy levels,Crystal Field Stabilization Energy (CFSE), Crystal field splitting in octahedral complexes, Crystal field splitting in tetrahedral complexes. Magnetic properties of complexes and CFT, Factor affecting the magnitude of crystal field splitting, Weak and strong ligand field splitting, Spectrochemical series and its characteristics. Crystal field effect on ionic radii, Lattice energies, and hydration energies of first row transition series, Limitations and advantages of CFT.	**8**
Unit IV	**Molecular Orbital Theory (MOT)** Molecular Orbital Theory (MOT) and its assumptions, Sigma bonding in tetrahedral and octahedral complexes, pi bonding in tetrahedral and octahedral complexes, Sigma and pi bonding in square planer complexes, Charge transfer spectra, Advantages of Molecular Orbital Theory (MOT), Comparison of VBT and CFT, Comparison of CFT and MOT, Comparison of VBT and MOT.	**8**
Study Resources	▪ Puri, B. R., Sharma, L. R., Kalia, K. C., (2006), Principle of Inorganic Chemistry, thirtieth edition, Milestone Publisher, Delhi. ▪ Lee, J. D., (1991), Concise Inorganic Chemistry, Fourth edition, Chapman and Hall. ▪ Huheey, J. E.,Keiter, E. A., Keitler R. L., (1993), Inorganic Chemistry Principles of Structure and Reactivity, fourth Edition, Harper Collins Publisher. ▪ Atkins, P., Overton T., Rourke J., Weller M., Armstrong F., (2009), Shriver and Atkins' Inorganic Chemistry, fifth edition, Oxford University Press. ▪ Pfennig, B. W., (2015), Principles of Inorganic Chemistry, John Wiley & Sons, Inc., Hoboken, New Jersey.	

T.Y. B. Sc. Chemistry (Major)
Semester-V
CHE-DSC-353:Organic Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To study different types of organic reactions. ▪ To understand the mechanisms of different types of reactions. ▪ To distinguish between types of substrates and types of reagents. ▪ To understand ways of attack of reagent, breaking and formation of bonds in different reaction mechanisms.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ learn organic reactions like nucleophilic substitution, electrophilic substitution, nucleophilic addition, electrophilic addition and elimination. ▪ able to write/ explain mechanisms of those types of reactions. ▪ understand how a reaction takes place in one or more steps. ▪ understand the types of intermediates formed in different reactions.	
Unit	**Contents**	**Hours**
Unit I	**Nucleophilic Substitution Reactions** S_N^1, S_N^2 and S_N^i reactions, Mechanism and stereochemistry, regioselectivity and stereo specificity of substitution reaction. Scope at saturated carbon, allylic carbon and vinylic carbon. Factors affecting rate of S_N^1, S_N^2 and S_N^i reactions (Effect of nature of substrate, nucleophile, leaving group and solvent).	**7**
Unit II	**Electrophilic Aromatic Substitution Reactions** Introduction, arenium ion mechanism, Mechanism of: Nitration, Sulfonation, Halogenation, Friedal-Crafts reactions (alkylation and acylation), Diazo Coupling reactions, Ipso-substitution, Effect of substituent group (Orientation, o/p directing and meta directing groups). Classification of substituent groups (activating and deactivating groups).	**8**
Unit III	**Electrophilic Addition Reactions** Introduction, Mechanism of electrophilic addition to C=C bond (AdE^2 Mechanism)**,** addition of hydrogen halides, orientation of addition: Markownikoff's and Anti Markownikoff's addition (peroxide effect), stereochemistry, addition of halogens: experimental evidences for two step mechanism, mechanism of addition of bromine, factors affecting anti-stereoselectivity, effect of substituents on rate of addition, Hydroxylation (Mechanism of formation of cis and trans 1,2-diols), Hydroboration- Oxidation	**8**

	(Formation of alcohol), Hydrogenation (Formation of alkane), Ozonolysis (formation of aldehydes & ketones).	
Unit IV	**Elimination Reactions** Introduction, The reaction mechanisms: E1, E2, E1CB with evidences and factors affecting the reaction.E1 v/s E2 and Elimination v/s substitution. Anti and Syn elimination, Stereo electronic factors. Bredt's rule. Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeff's elimination, Pyrolytic elimination.	**7**
Study Resources	▪ Clayden, J., Greeves, N., and Warren, S. (2012). Organic Chemistry. Oxford University Press, USA. ▪ Smith, M. B. (2020). March's Advanced Organic Chemistry: Reactions, Mechanisms, And Structure. John Wiley & Sons. ▪ Chauhan, M. S (2019). Solomons, Fryhle, Snyder, Organic Chemistry for JEE (Mains and Advanced). John Wiley & Sons. ▪ Madan, R. L. (2022). Chemistry for Degree Students B. Sc. First Year (LPSPE). S. Chand Publishing. ▪ Morrison, R., and Morrison, B. (1983). Boyd organic chemistry. Boston: Allen and Bacon.	

T.Y. B.Sc. Chemistry (Major)
Semester-V
CHE-DSC-354: Practical on Physical Chemistry-I

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To develop the experimental skills required in physical chemistry practicals. ▪ To expose the students to modern instrumental techniques and experimental methods. ▪ To learn how to collect, analyzeand interpret experimental data. ▪ To develop problem-solving skills using physical chemistry concepts.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ learn how to design, conductand perform experiments in physical chemistry with precision and accuracy. ▪ apply modern instrumentation to investigate physical chemistry phenomena. ▪ analyze and interpret data and draw the meaningful conclusionsfrom experimental findings. ▪ learn physical chemistry concepts to predict and explain experimental results.	
Sr. No.	**Contents**	**Hours**
1	To determine the concentration of hydrochloric acid and acetic acid in a given mixture by titrating it with a standard solution of sodium hydroxide conductometrically.	**4**
2	To determine the equivalent conductance of a strong electrolyte at several dilute solutions.	**4**
3	To determine the hydrolysis constant of sodium acetate conductometrically.	**4**
4	To determine the second order velocity constant for the hydrolysis of ethyl acetate by sodium hydroxide conductometrically.	**4**
5	To determine Ecal (oxid) and hence pH of given buffer solutions using quinhydrone electrode.	**4**
6	To determine the dissociation constant of acetic acid by potentiometric titration.	**4**
7	To determine the pH values of various mixtures of sodium acetate and acetic acid in aqueous solutions and find out the dissociation constant of	**4**

	the acid.	
8	To determine the dissociation constant of acetic acid pH-metrically.	**4**
9	To test the validity of Beer's-Lambert's law and hence determine the concentration of given unknown Cu^{++} solution colorimetrically/spectrophotometrically.	**4**
10	To investigate the kinetics of a reaction between potassium persulphate and potassium iodide.	**4**
11	To determine the energy of activation of the reaction between persulphate and potassium iodide.	**4**
12	To investigate the kinetics of iodination of acetone (zero order reaction).	**4**
13	To study the kinetics of inversion of cane sugar using polarimeter.	**4**
14	To determine the specific and molar refractivities of the given liquids A, B, C and D.	**4**
15	Calculations for the given data using Microsoft excel.	**4**
Study Resources	▪ Jeffery, G. H., Bassett, J., Mendham, J., Dennet, R. C., (1989), VOGEL's Textbook of Quantitative Chemical Analysis, Fifth Edition, Longman Scientific and Technical, England. ▪ Rose, J., (1964), Advanced Physico-Chemical Experiments- A Text Book of Practical Physical Chemistry and Calculations, Sir Isaac Pitman and Sons Ltd., London. ▪ Garland, C. W., Nibler, J. W., D. P. Shoemaker, (2003), Experiments in Physical Chemistry, Eighth Edition, McGraw-Hill Companies, Inc., New York. ▪ Yadav, J. B., (2008) Advanced Practical Physical Chemistry, Twenty Sixth Edition, Goel Publishing House- A Unit of Krishna Prakashan Media (P) Ltd., Meerut. ▪ Rajbhoj, S. W., Chondhekar, T. K., (2000), Systematic Experimental Physical Chemistry, Second Edition, Anjali Publication, Aurangabad.	

T.Y. B.Sc. Chemistry (Major)
Semester-V
CHE-DSC-355: Practical on Inorganic Chemistry-I

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To acquire the practical knowledge and analyse the inorganic mixtures. ▪ To understand the determination of metal from ore and alloy analysis. ▪ To get the knowledge of metal determination by colorimetric analysis	
Course Outcomes	After successful completion of this course, students are expected to: ▪ learn the determination cation and anion from inorganic mixtures byusing inorganic qualitative analysis. ▪ learn the determination of metal from ore and alloy analysis. ▪ learn the metal determination by colorimetric analysis.	
Sr. No.	**Contents**	**Hours**
	Inorganic Qualitative Analysis:	
1	Inorganic Qualitative Analysis of given binary mixture (mixture-1).	**4**
2	Inorganic Qualitative Analysis of given binary mixture (mixture-2).	**4**
3	Inorganic Qualitative Analysis of given binary mixture (mixture-3).	**4**
4	Inorganic Qualitative Analysis of given binary mixture (mixture-4).	**4**
5	Inorganic Qualitative Analysis of given binary mixture (mixture-5).	**4**
6	Inorganic Qualitative Analysis of given binary mixture (mixture-6).	**4**
7	Inorganic Qualitative Analysis of given binary mixture (mixture-7).	**4**
8	Estimation of Iron volumetrically from Heamatite ore.	**4**
	Ore Analysis:	
9	Estimation of Manganese volumetrically from Pyrolusite ore.	**4**
10	Estimation of Calcium volumetricallyDolomite ore.	**4**
11	Estimation of Zn from Brass alloy.	**4**
	Alloy Aanalysis:	
12	Estimation of Tin gravimetrically as SnO_2 from solder alloy.	**4**
13	Estimation of Copper iodometrically from nichrome alloy.	**4**
14	Determination of iron gravimetrically from stainless steel.	**4**
	Colorimetric Analysis:	
15	Colorimetric titration of Cu(II) against EDTA method.	**4**
16	Estimation of Titanium using hydrogen peroxide.	
Study Resources	▪ Mendham, J., (2009) Vogel's Quantitative Chemical Analysis ,6th Ed., Pearson. ▪ Svehla, G., (2002), Vogel's Qualitative Inorganic Analysis, Pearson	

	Education. ▪ Christian, G. D. (2006), Analytical chemistry,5th Edition, Wiley ▪ Mendham, J.,Denny R. C., Barnes, Thomas,(2009), Quantitative chemical analysis. ▪ Bassett, Denney, Jeffrery, (1989), Vogel's textbook of quantitative inorganic analysis. ▪ Nemade, A.M.,Zope, V.S.,Rajput, A.P.,Gujrathi, R.B.,A Textbook of Practical Chemistry,Prashant Publications. ▪ Patel, H. N., Turakhia, S. P., Kelker, S. S., Puniyani, S.R., (2010), College Practical Chemistry, Himalaya Publishing House.	

T.Y. B.Sc. Chemistry (Elective)
Semester-V
CHE-DSE-351A: Introduction to Analytical Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To learn the statistical analysis methods in analytical chemistry. ▪ To study the electrochromatography. ▪ To learn the methods of solvent extraction. ▪ To understand, water pollution and its analyzing methods.	
Course Outcomes	After successful completion of this course, students are expected to ▪ understand basic concepts of analytical chemistry. ▪ understand method involving electrophoresis and electrochromatography. ▪ gain knowledge of solvent extraction. ▪ know various methods involved in analysis of water pollution.	
Unit	**Contents**	**Hours**
Unit I	**Data handling and spreadsheets in Analytical chemistry** Errors in chemical analysis, Classification of errors systematic and random, Accuracy and precision, Mean, Median, Average deviation and standard deviation, Significant figures and rules to determine significant figures, Comparison of methods: F-test and T-test, Rejection of data based on Q-test.	**8**
Unit II	**Electrophoresis and Electrochromatography** Definition, Types of electrophoretic methods: Free solution electrophoresis, Tiselius method, Moving boundary electrophoresis, Zone electrophoresis or electrochromatography, Paper electrophoresis, Paper used, Electrode, Source of current, Requirements of electrophoretic chambers, Applications of electrochromatography.	**8**
Unit III	**Solvent Extraction** The Distribution Co-efficient, Distribution Ratio, Percent Extracted, Separation Efficiency of Metal Chelates (without derivation), Multiple Batch Extractions, Countercurrent Distribution (Craig's apparatus), Simple numerical problems on Percent Extracted and Multiple Extraction.	**8**

Unit IV	**Analysis of Water pollution** Water pollution, Water pollutants, Origin of waste water, Sources of water pollution, Types of water pollution, Water Analysis: Total dissolved solids, Hardness of water, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Test of BOD, Test of COD.	**6**
Study Resources	▪ Christian Gary D. (2015), Analytical Chemistry 6th edition, Wiley publication, Satyam enterprises, Delhi. ▪ Sharma B. K., (2012), Instrumental methods of chemical analysis 28th edition, GOEL publishing house, Krishna Prakashan media Ltd., Meerut, India. ▪ Willard, H. H., (1986), Instrumental Methods of Analysis, CBS Publishers, New Delhi. ▪ Skoog D. A., West D. M. and Holler F. J., (1992), Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth,Texas. ▪ Gupta Alka L., (2017), Analytical chemistry 8th edition, PragatiPrakashan, Meerut. ▪ Dean, J. A., (1992) Analytical Chemistry Notebook, McGraw Hill, New York. ▪ Vogel, A. I., (1996), Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, NewYork.	

T.Y. B.Sc. Chemistry (Elective)
Semester-V
CHE-DSE-351B:Pharmaceutical Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	• To study the role of chemistry in pharmaceuticals. • To study the mechanism involved in drug synthesis. • To study the formulation of desensitizing agent and anticaries agents. • To study the sources and indentification of impurities in pharmaceutical substances.	
Course Outcomes	After successful completion of this course, students are expected to ▪ understand the theories of drug action and biologically active natural products. ▪ apply the knowledge of drug synthesis for new drug findings. ▪ apply the knowledge of formulation for new product development. ▪ identify the impurities in pharmaceutical substances.	
Unit	**Contents**	**Hours**
Unit I	**Introduction of Pharmaceuticals Chemistry and Drugs** Important aspects of Pharmaceuticals Chemistry, Importance of Chemistry in Pharmacy, Classification of drugs, Theories of drug action: Nature of pharmacological action, Rate theory and Induced fit theory, Natural product as potential new drug, Natural product for drug discovery, Biologically active natural products.	**8**
Unit II	**Drugs and Pharmaceuticals** Introduction of drug class and synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (lbuprofen), antibiotics (Chloramphenicol), antibacterial and antifungal agents (Sulphonamides), antiviral agents (Acyclovir), Central Nervous System agents (Diazepam), Cardiovascular (Glyceryl trinitrate), Antineoplastic agent (Carmustine).	**8**
Unit III	**Dentrifrices- Desensitizing Agent-Anticaries Agents** Dentrifrices: Introduction, Classification, Tooth powder, Formulation of tooth powder, Abrasive and polishing material, Detergents and foaming additives, Sweetening agent, Flavouring substances, Toothpaste, Desensitizing agent, Antacaries Agents.	**7**
Unit IV	**Impurities in Pharmaceutical Substances** Sources of impurities in pharmaceutical chemicals, Effect of impurities,	**7**

	Permissible impurities in pharmaceutical substances, Purification of pharmaceutical substances, Test of Purity, Limit test-Arsenic, Lead, Sulphate, Iron and Heavy metals.	
Study Resources	• Chatwal, G. R. (2006), Medicinal Chemistry (Organic pharmaceutical Chemistry) Himalaya Publishing House, Bombay. • Kar, A. (2015), Medicinal Chemistry, New Age International Publisher, 6th edition, New Delhi. • Lemke, T. L., William, D. A. (2006), Foey's Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi. • Kar, A. (2008), Pharmaceutical Drug Analysis, New Age International Publisher, New Delhi. • Patrick, G.L.(1995,) Introduction to Medicinal Chemistry, Oxford University Press, UK. 65 • Kapoor, H. V. K., (2004), Medicinal and Pharmaceutical Chemistry, VallabhPrakashan, Pitampura, New Delhi.	

T.Y. B.Sc. Chemistry (Elective)
Semester-V
CHE-DSE-352 A: Practical on Organic Chemistry -I

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To develop skills required for qualitative analysis of organic compound. ▪ The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research. ▪ To expose the students to an extent of experimental techniques using green chemistry and modern instrumentation. ▪ The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ carry out qualitative analysis of organic compounds. ▪ separate and analyze binary water insoluble mixture. ▪ understand the purification techniques used in organic chemistry ▪ carry out synthesis of various organic compounds through greener alternatives.	
Sr. No.	**Topic Particular**	**Hours**
A	**Separation of organic Binary Mixtures and Qualitative Analysis (Minimum seven mixtures).**	
1	Separation of organic Binary Mixtures and Qualitative Analysis.	4
2	Separation of organic Binary Mixtures and Qualitative Analysis.	4
3	Separation of organic Binary Mixtures and Qualitative Analysis.	4
4	Separation of organic Binary Mixtures and Qualitative Analysis.	4
5	Separation of organic Binary Mixtures and Qualitative Analysis.	4
6	Separation of organic Binary Mixtures and Qualitative Analysis.	4
7	Separation of organic Binary Mixtures and Qualitative Analysis.	4
	Separation of organic mixture containing two components, identification of the components and preparation of suitable derivative if any. Note: ● Students are expected to determine type of the mixture and to separate the mixture. ● Separation of the Mixture should be done by chemical method only. ● It is expected to perform preliminary tests, physical constants, detection of elements and determination of functional groups of separated compounds. ● On the basis of above tests, students are expected to determine structure of compounds. ● The separated compounds should be purified and then melting point of purified compound should be determined. The purified samples of the separated components should be submitted. ● Separation and qualitative analysis of the binary Mixtures should be carried out on micro scale as far as possible.	

B	**Derivatives and their Preparations(Minimum fourderivatives).**	
8	Anilide derivative of carboxylic acid	**04**
9	Anhydride derivative of carboxylic acid.	**04**
10	Aryloxy acetic acid derivative of phenol.	**04**
11	Bromo derivative of phenol and nitro phenol.	**04**
12	Benzoyl Derivative of Phenol	**04**
13	2, 4 DNP derivative of aldehydes or Ketones	**04**
C	**Synthesis involving Green Chemistry Principles (Any four).**	
14	Synthesis of acetanilide from aniline by using Zn dust / acetic acid.	**04**
15	Synthesis of dibenzalpropanone from benzaldehyde and acetone. using $LiOH.H_2O$/NaOH.	**04**
16	Synthesis of p- bromo acetanilide from acetanilide by using KBr.	**04**
17	Synthesis of dihydropyrimidinone from ethyl ace to acetate, benzaldehyde and urea.	**04**
18	Diels-Alder reaction between furan and maleic acid [4+2] Cycloaddition Reaction.	**04**
Study Resources	▪ Vogel A. I., (2005), Practical Organic Chemistry, 5th Edition Pearson. New York ▪ Agarwal O. P., (2014), Practical Organic Chemistry, Krishna Prakashan Media (P) Ltd, Meerut, India ▪ Kamboj P. C., (2013,) University Practical Chemistry, 1st (Reprint) Edition, Vishal Publishing Co. Jalandhar, India ▪ Ahluwalia V. K. and Aggarwal Renu, (2016), Comprehensive Practical Organic Chemistry-Qualitative Analysis Universities Press, Hyderabad, India ▪ Woodward R.B. and Baer H., J. Am. Chem. Soc. 1948, 70, 1161. ▪ Rideout D. C. and Breslow R., J. Am. Chem. Soc. 1980, 102, 7816. ▪ Anastas, P.T and Warner, J.C (1998), Green Chemistry: Theory and Practice, J.C. Oxford University Press. New York ▪ Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST Page 69 of 70, India	

T.Y. B.Sc. Chemistry (Elective)
Semester-V
CHE-DSE-352B: Practical on Analytical Chemistry-I

Total Hours: 60 **Credits: 2**

Course objectives	▪ To provide hands-on experience with analytical techniques. ▪ To develop proficiency in using modern instrumentation and methods for qualitative and quantitative chemical analysis. ▪ To understand the principles of molecular separation, extraction efficiency, and water quality assessment. ▪ To enhance the ability to interpret experimental data and apply statistical tools for validation and accuracy assessment.	
Course Outcomes	After successful completion of this course, students are expected to ▪ Demonstrate the ability to separate and identify complex mixtures using electrochromatography. ▪ Perform liquid-liquid and solid-liquid extractions for isolating and purifying chemical compounds. ▪ Analyze water quality parameters, including hardness, fluoride content, dissolved oxygen, and COD. ▪ Apply statistical tools such as t-tests, ANOVA, and standard deviation for analyzing experimental data.	
Sr. No.	**Contents (Any 15)**	**Hours**
1	To evaluate the precision of experimental data by calculating standard deviation and relative standard deviation.	**4**
2	To perform a t-test for comparing the results of two analytical methods for the same analyte.	**4**
3	To assess the accuracy of an analytical method by calculating recovery percentages.	**4**
4	To apply ANOVA for analyzing variance in results obtained from different experimental setups.	**4**
5	To create and interpret calibration curves for quantitative analysis.	**4**
6	To separate amino acids using capillary electrochromatography	**4**

	and analyze their migration patterns.	
7	To determine the purity of pharmaceutical compounds using electrochromatographic techniques.	**4**
8	To investigate the effect of pH on the separation efficiency of charged molecules in electrochromatography.	**4**
9	To optimize the separation of polyaromatic hydrocarbons in an electrochromatographic setup.	**4**
10	To study the interaction of proteins with stationary phases using electrochromatography	**4**
11	To extract caffeine from tea leaves using liquid-liquid extraction and determine its concentration spectrophotometrically.	**4**
12	To separate metal ions using solvent extraction and evaluate the efficiency of different organic solvents.	**4**
13	To study the partition coefficient of iodine between water and organic solvents.	**4**
14	To optimize the conditions for extracting dyes from aqueous solutions.	**4**
15	To isolate essential oils from natural products through solvent extraction techniques.	**4**
16	To determine the hardness of water samples using complexometric titration.	**4**
17	To estimate the concentration of fluoride ions in drinking water using ion-selective electrodes.	**4**
18	To analyze dissolved oxygen (DO) levels in water samples using Winkler's method.	**4**
19	To measure the chemical oxygen demand (COD) of industrial waste water.	**4**
20	To assess the pH, conductivity, and total dissolved solids (TDS) in local water samples.	**4**
Study Resources	▪ Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2017). Fundamentals of Analytical Chemistry (10th ed.). Cengage Learning. ▪ Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J.,	

	& Smith, P. W. G. (1996). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Prentice Hall. ▪ Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). Vogel's Textbook of Quantitative Chemical Analysis (5th ed.). Longman. ▪ Harvey, D. (2000). Modern Analytical Chemistry. McGraw-Hill. ▪ Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2000). Vogel's Quantitative Chemical Analysis (6th ed.). Pearson Education.	

T.Y. B.Sc. Chemistry (Vocational)
Semester-V
CHE-VSC-351: Green Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To understand the fundamentals and importance of green chemistry ▪ To study design of greener chemical synthesis ▪ To understand the 12 principles and the tolols of green chemistry ▪ To study chemical reactions in aqueous medium as green solvent	
Course Outcomes	After successful completion of this course, students are expected to: ▪ comprehend the knowledge about the concept of Green chemistry. ▪ apply their knowledge to design a greener chemical synthesis ▪ understand the 12 principles of Green chemistry ▪ understand the importance of aqueous medium as green solvent	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Green Chemistry** Introduction, origins of green chemistry**,** need of green chemistry, goal of green chemistry, and applications of green chemistry.	**7**
Unit II	**Designing a Green Synthesis** Choice of starting materials, reagents, choice of catalysts, choice of solvents, and energy requirement-ultrasound assisted reactions.	**5**
Unit III	**Twelve Principles of Green Chemistry** Waste prevention, atom economy, safer synthesis, safer products, safer auxiliaries, energy efficiency, renewable feedstocks, derivative reduction, catalysis, degradability, pollution prevention, and accident prevention.	**10**
Unit IV	**Green Reactions in Aqueous Medium** Types of reactions in aqueous medium and associated nomenclature, on-water reactions-Diels–Alder reaction, Passerini reaction, Claisen rearrangement, superheated water and its properties, and organic reactions in superheated water.	**8**
Study Resources	• Kolb, V. M. (2017). Green Organic Chemistry and Its Interdisciplinary Applications. CRC Press, USA. • Anastas, P. T., Warner, J. C. (2000). Green Chemistry: Theory and Practice. Oxford University Press, Oxford. • Ahluwalia, V. K., Kidwai, M. (2004). New Trends in Green Chemistry. Kluwer Academic Publishers with Anamaya Publishers: New Delhi, India. • Ryan, M. A., Tinnesand, M. (2002). Introduction to Green Chemistry: Instructional Activities for Introductory Chemistry. American Chemical Society, USA. • Dey, S. P., Sepay, N. (2021). A Textbook of Green Chemistry- First edition. Techno World, Kolkata.	

T.Y. B.Sc. Chemistry (Vocational)
Semester-V
CHE-VSC-352: Practical on Green Chemistry

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To provide better understanding of green chemistry and its principles ▪ To study applicability of green chemistry in various industrial processes ▪ To provide examples of green chemistry experiments as better alternative to classic undergraduate organic chemistry laboratory experiments	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand green chemistry and its principles ▪ understand use of green chemistry in various industrial processes ▪ to apply experimental knowledge to develop green alternative to chemical reactions	
Sr. No.	**Contents**	**Hours**
1	Introduction to designing a green process-prelab preparation	**4**
2	Preparation of **benzilic acid** using NaOH/KOH under solvent-free conditions.	**4**
3	Synthesis of dihydropyrimidinone from ethyl acetoacatate, benzaldehyde and urea.	**4**
4	Synthesis of polyvinylpyrrolidone (**PVP**)	**4**
5	To perform the Aldol condensation reaction in solid phase.	**4**
6	Micelle assisted reduction of aromatic carbonyl compounds (any aldehyde, ketone or ester) in water using sodium borohydride	**4**
7	Bromination of **acetanilide** using bromide source and cerric ammonium nitrate.	**4**
8	Synthesis of p-acetamidophenol from p-aminophenol	**4**
9	The **alcohol dehydration reaction** (Zaitsev Elimination) using montmorillonite KSF clay	**4**
10	Synthesis of substituted benzyl alcohol from benzaldehyde using green alternative of **grignardreagent**	**4**
11	Esterification of waste **vegetable oil** for biodiesel production	**4**
12	Synthesis of soap	**4**
13	Synthesis of dibenzalpropanone from benzaldehyde and acetone	**4**
14	Synthesis of **aspirin**	**4**
15	Photo reduction of benzophenone to benzopinacol in presence of sun light using isopropanol and acetic acid	**4**
Study Resources	▪ Vogel, I. (1974). Practical Organic Chemistry. Longman, USA. ▪ Mann, F. G.; Saunders, B. C. (2009) Practical Organic Chemistry-Fourth Edition. Pearson Education, India. ▪ Clarke, H. T. (2021). A Handbook of Quantitative & Qualitative Analysis- Fourth Edition. CBS Publishers and Distributors Pvt. Ltd. New Delhi. ▪ A Guide to Green Chemistry Experiments for Undergraduate Organic Chemistry Labs-MilliporeSigma	

	A-Guide-to-Green-Chemistry-Experiments-for-Undergraduate-Organic-Chemistry-Labs.pdf	

T.Y. B.Sc. Chemistry (On Job Training)
Semester-V
CHE-OJT-351: On Job Training /Internship

Total Hours: 120 **Credits:4**

Course objectives	• To provide the students with actual work experience. • To make aware prescribe standards and guidelines at work. • To develop the employability of participating student. • To avail an opportunities to eventually acquire job experiences
Course outcomes	After successful completion of this course, students are expected to: • get actual work experience with office and virtual exposure to various management styles, technical, industrial, and proceduralsystems. • acquaint the knowledge related to working hours, work protocols and guidelines • understand the roles and responsibilities of employee as well as team work • justify job experiences that match their potentials, skills, and competencies

Internship

An internship is a professional learning experience that offers meaningful, practical work related to a student's field of study or career interest. An internship gives a student the opportunity for career exploration and development, and to learn new skills.

On the job training

On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.

Internship / OJT Mechanism:

1. **Pre-Approval**: Students should seek approval from the college before starting the Internship / OJT. This ensures that the Internship / OJT aligns with the curriculum and meets the necessary criteria.
2. **Mentor and Supervisor**: Each student should have an assigned mentor at the organization/industry where they are interning. Additionally, anInternship / OJT supervisor from the college will be appointed to guide and monitor the progress.
3. **Regular Reporting:** Students should maintain regular communication with their supervisor and mentor, providing progress reports and seeking feedback.
4. **Professional Conduct**: Students must adhere to professional conduct throughout the Internship / OJT, including punctuality, respect for colleagues, and adherence to the organization's/industry's policies and guidelines.
5. **Student Diary**: Students should maintain a diary to document their experiences, challenges faced, and lessons learned during the Internship / OJT.
6. **Final Report**: At the end of the Internship / OJT, students should submit a comprehensive final report, summarizing their accomplishments, contributions, and key takeaways.
7. **Evaluation**: The Internship / OJT is worth 4 credits (equivalent to 100 marks), and the evaluation will be divided into two categories: one by the mentor and the other by the Internship / OJT supervisor. The mentor's evaluation (internal examination) will carry 40 marks, and it will be based on the student's performance during the Internship / OJT. External examination will be conducted by mentor and supervisor which will be based on the student's diary, the final report prepared by the student, and their performance in the final viva voce, and will carry60 marks. The total marks obtained by the students in both evaluations will be added together for the purpose of final evaluation. The evaluation of the students will be conducted by the mentor using the evaluation sheet provided by the college.

Internal Evaluation Criteria for Students by the Mentor:

1. **Quality of Work** (10 marks): How well did the student perform their assigned tasks during the Internship / OJT? Evaluate the accuracy, thoroughness, and attention to detail in their work.
2. **Initiative and Proactiveness**(10 marks): Did the student show initiative in taking on additional responsibilities or tasks beyond their assigned role? Did they demonstrate a proactive attitude towards problem-solving?
3. **Communication Skills** (10 marks): Assess the student's ability to communicate effectively with colleagues, superiors, and clients (if applicable). Consider both written and verbal communication.
4. **Problem-Solving SkillsandTime Management** (10 marks): Evaluate the student's ability to analyze problems, propose solutions, and implement effective strategies to overcome challenges.How well did the student manage their time during the Internship / OJT? Were they able to meet project deadlines and handle multiple tasks efficiently?

External Evaluation Criteria for Students by the Supervisor and Mentor:

1. **Student Diary** (15 marks): Review the student's diary to understand their reflections, insights gained, and self-assessment of their performance during the Internship / OJT.
2. **Final Report** (15 marks): Evaluate the quality and comprehensiveness of the student's final report, including the clarity of their achievements and contributions.
3. **Presentation of Student in Viva Voce** (30 marks): Evaluate the responses given by the student to the questions asked by the faculty in the Viva Voce.

Evaluation Criteria for Final Viva Voce:

1. Presentation Skills
2. Knowledge of the Internship / OJT Project
3. Practical Application and Work Experience
4. Problem-Solving and Critical Thinking
5. Communication and Professionalism

SEMESTER-VI

T.Y. B.Sc. Chemistry (Major)
Semester-VI
CHE-DSC-361: Concepts in Physical Chemistry

Total Hours: 30 **Credits: 2**

Learning objectives	• To learnthe knowledge about quantum chemistry. • To learnthe important concepts of thermodynamics. • To learn about the significance of photochemistry. • To enrich the understanding of solid state chemistry.	
Course outcomes	After successful completion of this course, students are expected to: • understandthe concepts of black body radiation and quantum theory. • understand the concetps of entropy, free energy function and work function. • understand the photochemical processesand significance of quantum yield. • understand the concepts of crystal structure, classification of crystals and crystal defects.	
Unit	**Topic Particular**	**Hours**
Unit I	**Quantum Chemistry** Introduction, Black body radiation and quantum theory, Distribution of energy in black body radiation, Photoelectric effect: Wave-particle duality of radiation, Quantum theory and atomic spectra, Bohr model, Wave-particle duality of material particles and de Broglie's hypothesis, Uncertainty principal, Related numericals.	**8**
Unit II	**Thermodynamics** Entropy change accompanying change of phase, Free energy function and work function, Variation of free energy with temperature, Isothermal change in free energy, Gibb's-Helmholtz equation, Related numericals.	**8**
Unit III	**Photochemistry** Introduction, Differences between thermal and photochemical processes, Laws of photochemistry: Grothus-Draper law and Stark-Einstein law of photochemical equivalence, Primary and secondary reactions, Quantum yield, Calculation of quantum yield, Photosensitized reactions, Photophysical processes: Fluorescence and phosphoresence, Jablonski diagram, Chemiluminescence, Related numericals.	**7**
Unit IV	**Solid State Chemistry** Introduction, Crystal structure, Cubic unit cells and its types (simple, body-centred and face-centred cubic unit cell), Bragg's equation, Classification of crystals on the basis of bonds (Ionic, Molecular, Network covalent and Metallic crystals), Structure of metal crystals, Types of close-packed metallic crystals: Hexagonal and cubic close-packed, Related numericals.	**7**

Study References	▪ Maron, S. H., and Prutton, C. F. (2012). Principles of Physical Chemistry (4th Edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. ▪ Bahl, B. S., Bahl, A., and Tuli, G. D. (2005). Essentials of Physical Chemistry, S. Chand and Co Ltd., New Delhi. ▪ Puri, B. R., Sharma, L. R., and Pathania, M. S. (2007). Principles of Physical Chemistry (42nd Edition), Vishal Publishing Co., Jalandhar. ▪ Atkins, P. W. (1998). Physical Chemistry, ELBS. ▪ Barrow, G. M. (2003). Physical Chemistry, International Student Edition. ▪ Moore, W. J. (1998). Physical Chemistry, Orient Longman. ▪ McQuarrie, D. A., and Simon, J. D. (2006). Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi. ▪ Levine, I. N. (1983). Quantum Chemistry (Third Edition), Allyn and Bacon. ▪ Hanna, M. (1970). Quantum Mechanics in Chemistry, John Wiley and Sons. ▪ Prasad, R. K. (1992). Quantum Chemistry, Wiley Eastern Ltd.. ▪ Chandra, A. K. (1979). Introductory to Quantum Chemistry, Tata McGraw Hill. ▪ Glasstone, S. (1965). Thermodynamics for Chemist, Van Nostrand, East-West. ▪ Rohatgi-Mukherjee, (1986), Fundamentals of Photochemistry, Revised Edition, New Age International (P) Limited Publishers, New Delhi. ▪ Azaroff, L. V., (1977), Introduction of Solid, Tata McGraw Hill, New Delhi. ▪ West, A. R., (1999), Basic Solid State Chemistry, John Wiley and Sons Ltd., USA.	

T.Y. B.Sc. Chemistry (Major)
Semester-VI
CHE-DSC-362: Advanced Inorganic Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	▪ to acquire the knowledge of organometallic compounds. ▪ to introduce bioinorganic chemistry. ▪ to study inorganic polymers. ▪ to study and apply the knowledge of inorganic chemistry in the field of environmental chemistry.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ understand the structure and reactions organometallic compounds. ▪ know the elements involved in biological system through bioinorganic chemistry. ▪ get the knowledge of different types of useful inorganic polymers. ▪ learn the elements from environmental chemistry.	
Unit	**Contents**	**Hours**
Unit I	**Organometallic compounds** Organometallic compounds an introduction, classification of organometallic compounds based on nature of metal-carbon bond: 1) Ionic organometallic compounds 2) Compounds containing metal-sigma bond, 3) Ylids 4) Organometallic compounds with multicentre bonds 5) Organometallic compounds with pi bonded ligands. Bonding in pi-metal organometallic complexes, Ferrocene: aromatic character, preparation, and reactions (Nitration, halogenation, Vilsmeir and Mannich condensation reaction), Aromaticity of cyclic $C_nH_n$ligands. Ziegler-Natta catalyst. Inert gas rule.	**8**
Unit II	**Bioinorganic Chemistry** Introduction of Bioinorganic Chemistry, role ofmyglobin and hemoglobin in biological system. Metallo-enzymes: carbonic anhydrase, carboxy peptidase, peroxidases, catalases, cytochrome P-450. Inhibition and poisoning of enzymes, role of alkali and alkaline earth metal ions in biological system, biological and toxicity some elements, biological fixation of nitrogen.	**7**
Unit III	**Inorganic Polymers** Inorganic polymers: an introduction, properties of inorganic chemistry, glass transition temperature. 1) Phosphorus-based polymers: a) Phosphorus-based chain polymers: Plyphosphazines, Polyposphonitrilic chlorides, Polyphosphoryl Chlorides. b) Phosphorus-based network polymers: Plymeric phosphorus	**8**

	Pentaoxide, Polyorthophosphates of boron, Polymeric silver phosphate, borophoshate glasses. 2) Sulphur-based polymers: Polymeric sulphur, polymeric sulphur nitride, chalcogenide glasses. 3) Boron-based polymers: Polyboranes, polymeric boron nitride 4) Silicon-based Polymers: organosilicones, silicone rubber, silicon resins. 5) Coordination polymers: natural and synthetic coordination polymers.	
Unit IV	**Environmental chemistry** Environment chemistry; an introduction. Air pollution: air pollutant (Carbon Monoxide, Carbon dioxide, Chlorine, Nitric acid rain, Sulphuric acid rain, Hydrogen sulphide, effect of nitrogen oxide and fluorocarbons on ozone layer. Particulates: sources of particulates, effect on visibility and materials, toxic effect of particulates on humans. Smog; Mechanism of the formation of photochemical smog, Pesticides and their adverse side effect, Insecticides: stomach poisons, contact poisons, fumigants. Fungicides, herbicides, Rodenticides. Various water pollutant: sewage and other oxygen-demanding wastes, plant nutrients, exotic organic chemicals, inorganic chemical and minerals like Lead, Arsenic, Cadmium etc.	**7**
Study Resources	▪ Puri, B. R., Sharma, L. R., Kalia, K. C., (2006), Principle of Inorganic Chemistry, thirtieth edition, Milestone Publisher, Delhi. ▪ Lee J. D., (1991), Concise Inorganic Chemistry, Fourth edition, Chapman and Hall. ▪ Huheey, J. E.,Keiter, E. A., Keitler R. L., (1993), Inorganic Chemistry Principles of Structure and Reactivity, fourth Edition, Harper Collins Publisher. ▪ Atkins, P., Overton T., Rourke J., Weller M., Armstrong F., (2009), Shriver and Atkins' Inorganic Chemistry, fifth edition, Oxford University Press. ▪ Lekishvili N., Kopylov, V.andZaikov G., (2010), Silicon-Organic Oligomers and Polymers with Inorganic and Organic-InorganicMain Chains, Nova SciencePublishers, Inc., New York (ISBN 978-1-62100-522-3).	

T.Y. B.Sc. Chemistry (Major)
Semester-VI
CHE-DSC-363: Organic Spectroscopic Methods

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To study principle of spectroscopy and to understand wave parameters and terms involved in spectroscopy. ▪ To study different types of spectroscopy. ▪ To understand principle, concept and the terms used in each type of spectroscopy. ▪ Interpretation of UV, IR, NMR spectra.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ Students will learn interaction of radiations with matter. They will understand different regions of electromagnetic radiations. They will know different wave parameters. ▪ Students will understand principle of UV spectroscopy and nature of UV spectrum. They will learn types of electronic excitations. ▪ Students will understand principle of IR spectroscopy, types of vibrations and the nature of IR spectrum. ▪ Students will understand principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Spectroscopy** ▪ Introduction, meaning of spectroscopy, nature of electromagnetic radiation, wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength and frequency, different regions of electromagnetic radiations. Interaction of radiation with matter. Excitation of molecules with different energy levels, such as rotational, vibrational and electronic level. Types of spectroscopy, advantages of spectroscopic methods	**5**
Unit II	**Ultra Violet Spectroscopy** ▪ Introduction, nature of UV spectrum, Beer's law, absorption of UV radiation by organic molecule leading to different excitations. Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift (Red shift), hypsochromic shift (Blue shift), hyperchromic and hypochromic effect. Effect of conjugation on position of UV band. Calculation of λ-max by Woodward and Fisher rules: for dienes and enone system, Applications of UV Spectroscopy: Determination of structure, determination of stereo chemistry (cis and trans), problems.	**8**
Unit III	**Infra-red Spectroscopy** ▪ Introduction, Principle of IR Spectroscopy, fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Regions of IR Spectrum: functional group region, finger print region and aromatic region, Characteristic IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (- CHO, C=O, -COOR, -COOH), amines, amides and Aromatic Compounds and their substitution	**7**

	Patterns. Factors affecting IR absorption: Inductive effect, resonance effect, hydrogen bonding. Applications of IR Spectroscopy: determination of structure, chemical reaction and hydrogen bonding, Problems.	
Unit IV	**NMR and Mass Spectroscopy** ▪ A] **NMR Spectroscopy:** Introduction, Principles of NMR Spectroscopy, Magnetic and nonmagnetic nuclei, Precessional motion of nuclei without mathematical details, Nuclear resonance, chemical shift, shielding, &deshielding effect. Measurement of chemical shift, delta and Tau-scales. TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, *J*-value (Only first order coupling be discussed), problems. B]**Mass spectroscopy:** Basic theory, Nature of mass spectrum, Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula.	**10**
Study Resources	▪ Fleming, I., & Williams, D. H. (1966). Spectroscopic methods in organic chemistry (p. 56). New York: McGraw-hill. ▪ Kalsi, P. S. (2007). Spectroscopy of organic compounds. New age international. ▪ Small, G. W. (1992). Spectrometric identification of organic compounds. Vibrational Spectroscopy, 4(1), 123-124. ▪ Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2015). Introduction to spectroscopy.	

T.Y. B.Sc. Chemistry(Major)
Semester VI
CHE-DSC-364: Chemistry of Polymers

Total Hours: 30 **Credits: 2**

Course objectives	• To study the basic concept of polymerization. • To study the different types of polymerization methods. • To study the different techniques of polymerization. • To study the preparation, properties, and applications of industrially important polymers.	
Course outcomes	After successful completion of this course, students are expected to • understand the type, class and stereochemistryof polymers. • understandthe synthesis of polymers using the key stages: initiation**,** propagation, andtermination with kinetics. • choose the proper polymer processing technique for the formation of polymers. • To explore the knowledge of polymer chemistry for synthesis of new industrially important polymers.	
Unit	**Contents**	**Hours**
Unit I	**Basic Concepts of Polymers** Introduction, brief history, monomers and polymers, degree of polymerization, functionality, linear, branched and cross-linked polymers, homo polymers, Types of copolymers: -random, alternate, block and graft copolymers, Tacticity(stereochemistry)of polymers: isotactic, syndiotactic and atactic polymers. Classification of polymers: -based on a) origin-natural and synthetic polymers b) native back bone chain –organic and inorganic polymers c) thermal response–thermoplastic and thermosetting polymers d) ultimate form and use–plastic, elastomer, fibre and liquid resin, Degradation of polymers: types of degradation: chain end and random degradations.	**7**
Unit II	**Chemistry of Polymerization** Introduction, chain growth polymerization (initiation, propagation, termination, and kinetics): free radical polymerization, ionic (cationic and anionic) polymerizations, step growth polymerization (mechanism), ring opening polymerization.	**8**
Unit III	**Polymerization Techniques &Polymer Processing Techniques** Polymerization techniques: - Bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, interfacial condensation polymerization. Polymer processing techniques: -Calendaring,	**6**

	diecasting, filmcasting, and compression moulding.	
Unit IV	**Study of Some Important Polymers** Preparation, properties and applications of-Polyethylene [PE], Polypropylene [PP], Poly (vinyl chloride) [PVC], Polystyrene [PS], Polyacrylonitrile [PAN], Polycarbonates [PC], Phenol-formaldehyde resins [PF], Epoxy resins, Polyester-Polyethylene terephthalate [PET], Polyamides (Nylon-6andNylon-6,6), Poly (vinyl alcohol) [PVA], Poly (lactic acid) [PLA].	**9**
Study Resources	• Govarikar V.R., Viswanathan, N. V., JayadevSreedhar, (1997), Polymer Science, New Age International (P) Ltd. New Delhi, India. • Billmeyer, F. W. (1984), Textbook of polymer science. John Wiley & Sons, Canada. • Seymour, F. B. (Ed.). (2012), Pioneers in polymer science, Springer Science & Business Media, USA. • Odian, G. (2004), Principles of polymerization. John Wiley & Sons, Canada. • Ghosh, P. (1990), Polymer science and technology. Tata McGraw-Hill Education, Kolkata, India. • Lenz, R. W. (1967), Organic chemistry of synthetic high polymers, USA.	

T.Y. B.Sc. Chemistry (Major with IKS)
Semester-VI
CHE-DSC-365:Chemistry in Ancient India

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To study Atomism in Classical Indian Philosophy. ▪ To understand the role of Acharya Nagarjun in Bhartiya Chemistry. ▪ To study Chemistry through Vedic Knowledge System. ▪ To learn the Chemistry in Ayurvedic period.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ learn Atomism in Classical Indian Philosophy. ▪ know the role of Acharya Nagarjun in Bhartiya Chemistry ▪ understand Chemistry through Vedic Knowledge System. ▪ understand Chemistry in Ayurvedic period.	
Unit	**Contents**	**Hours**
Unit I	**Atomism in Classical Indian Philosophy**: *Nyāya-Vaiśeṣika* atomism theories from *veda*, Buddhist atomism theories, Jaina atomism theories, Early Modern Indian Atomism. Atom and Molecule in Ancient India.	**8**
Unit II	**Acharya Nagarjun: A gem of Bhartiya Chemistry:** Introduction, Contribution to Chemistry, Innovative techniques, Philosophical Underpinnings, Influence on Modern Chemistry, Laboratory and apparatus in Acharya Nagarjun's Alchemical Practices.	**7**
Unit III	**Chemistry through Vedic Knowledge system:** Vedic Knowledge an Introduction, Influence of Vedic System on Modern Chemistry, *Vaisesika* and Chemistry.	**7**
Unit IV	**Chemistry in Ayurvedic period:** The constitution and Properties of Matter, The *Samkhya-Patanjala* view of process of Cosmetic Evolution. Chemistry in *Kautilya*. Chemistry in *Charaka* and *Susruta*. Chemistry in *Vabhata*. different types of bhasmas: Gold, silver, copper and Lead bhasma	**8**
Study Resources	▪ Gangopadhyay M; Indian atomism: history and sources (1980), K. P. Bagchi and Company, Calcutta. ▪ Bal Ram Singh; Use of Chemistry to Understand Vedic Knowledge, In: Contemporary Views on Indian Civilization, edited by Bhu Dev Sharma, (2003) World Association of Vedic Studies, USA, 388-399. ▪ Berryman, Sylvia, "Ancient Atomism", *The Stanford Encyclopedia of Philosophy* (Winter 2022 Edition), Edward N. Zalta& Uri Nodelman (eds.).	

	▪ ShashikantAwasthi ; Indian Knowledge Systems: A Comprehensive Analysis of Various Contexts (2024) Shashwat Publication. ▪ Ray PrafullaCharndra Acharya; History of Chemistry in ancient and Medieval India: Incorporating the History of Hindu Chemistry (1956), Indian Chemical Society, Calcutta.	

T.Y. B.Sc. Chemistry (Major)
Semester-VI
CHE-DSC-366: Practical on Physical Chemistry-II

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To develop the experimental skills required in physical chemistry practicals. ▪ To expose the students to modern instrumental techniques and experimental methods. ▪ To learn how to collect, analyzeand interpret experimental data. ▪ To develop problem-solving skills using physical chemistry concepts.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ learn how to design, conductand perform experiments in physical chemistry with precision and accuracy. ▪ apply modern instrumentation to investigate physical chemistry phenomena. ▪ analyze and interpret data and draw the meaningful conclusionsfrom experimental findings. ▪ learn physical chemistry concepts to predict and explain experimental results.	
Sr. No.	**Contents**	**Hours**
1	To investigate the conductometric titration of oxalic acid with sodium hydroxide.	**4**
2	To determine the hydrolysis constant of the aniline hydrochloride conductometrically.	**4**
3	To determine the strength of hydrochloric acid by titrating it with a standard solution of sodium hydroxide potentiometrically.	**4**
4	To determine the dissociation constant of chloroacetic acid by potentiometric titration.	**4**
5	To construct the calibration curve (pH – Eobs.) of quinhydrone electrode and hence the standard oxidation potential of the electrode.	**4**
6	To determine the hydrolysis constant of aniline hydrochloride pH-metrically.	**4**
7	To determine the dissociation constant of chloroacetic acid by pH-metric titration.	**4**
8	To test the validity of Beer's-Lambert's law and hence determine the concentration of given unknown KMnO4 solution colorimetrically/spectrophotometrically.	**4**
9	To determine the order of reaction between potassium persulphate and potassium iodide by fractional change method.	**4**
10	To study the hydrolysis of methyl acetate in presence of hydrochloric acid.	**4**
11	To investigate the reaction between H_2O_2 and KI by gas burette method.	**4**
12	To determine the density of a given liquid using density bottle.	**4**
13	To determine the concentration of given solution of an optically active substance (cane sugar) by polarimetric measurement.	**4**

14	To determine the molar refractive indices of series of KCl solution and hence unknown concentration of given KCl solution.	**4**
15	Draw the two graphs of the given data using Microsoft excel.	**4**
Study Resources	▪ Jeffery, G. H., Bassett, J., Mendham, J., Dennet, R. C., (1989), VOGEL's Textbook of Quantitative Chemical Analysis, Fifth Edition, Longman Scientific and Technical, England. ▪ Rose, J., (1964), Advanced Physico-Chemical Experiments- A Text Book of Practical Physical Chemistry and Calculations, Sir Isaac Pitman and Sons Ltd., London. ▪ Garland, C. W., Nibler, J. W., D. P. Shoemaker, (2003), Experiments in Physical Chemistry, Eighth Edition, McGraw-Hill Companies, Inc., New York. ▪ Yadav, J. B., (2008) Advanced Practical Physical Chemistry, Twenty Sixth Edition, Goel Publishing House- A Unit of Krishna Prakashan Media (P) Ltd., Meerut. ▪ Rajbhoj, S. W., Chondhekar, T. K., (2000), Systematic Experimental Physical Chemistry, Second Edition, Anjali Publication, Aurangabad.	

T.Y. B.Sc. Biochemistry (Major)
Semester-VI
CHE-DSC-367: Practical on Inorganic Chemistry-II

Total Hours: 60 **Credits: 2**

Course Objectives	▪ To understand the procedure behind Gravimetric estimations. ▪ Students perform Inorganic Preparations. ▪ Understand Volumetric Analysis.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ know the procedure of gravimetric estimations. ▪ perform inorganic preparations. ▪ understand volumetric analysis.	
Sr. No.	**Contents**	**Hours**
	Gravimetric Estimations	
1	Gravimetric estimation of Fe as Fe_2O_3.	**4**
2	Gravimetric estimation of Zn as $Zn_2P_2O_7$.	**4**
3	Gravimetric estimation of Pb as lead chromate.	**4**
4	Gravimetric estimation of Al as Al_2O_3.	**4**
	Inorganic Preparations	
5	Preparation of Bis (ethylenediamine) copper (II) sulphate.	**4**
6	Preparation of Potassium trioxalato chromate (III).	**4**
7	Preparation of Tris (acetylacetonato) Iron (III).	**4**
8	Preparation of Hexaaquonickel (II) chloride.	**4**
9	Preparation of Potassium trisoxalatoaluminate (III)trihydrate.	**4**
10	Preparation of Synthesis of ZnO nanoparticles using Zinc acetate dihydrate.	**4**
	Volumetric Analysis	
11	Estimation of Manganese by Volhards method.	**4**
12	Estimation of Nickel by EDTA method.	**4**
13	Determination of strength of NaOH and Na_2CO_3in a given solution.	**4**
14	Estimation of ferrous and ferric by dichromate method.	**4**
15	**Paper Chromatography: (any Two mixtures)**	**4**

	Separation and identification of binary mixture of cations (Fe^{3+},Ni^{2+}, Cu^{2+},Co^{2+},Mn^{2+},Zn^{2+}).	
Study Resources	▪ Mendham, J., (2009) Vogel's Quantitative Chemical Analysis ,6th Ed., Pearson. ▪ Svehla, G., (2002), Vogel's Qualitative Inorganic Analysis, Pearson Education. ▪ Christian, G. D. (2006), Analytical chemistry,5th Edition, Wiley ▪ Mendham, J.,Denny R. C., Barnes, Thomas,(2009), Quantitative chemical analysis. ▪ Bassett, Denney, Jeffrery, (1989), Vogel's textbook of quantitative inorganic analysis. ▪ Nemade, A.M.,Zope, V.S.,Rajput, A.P.,Gujrathi, R.B.,A Textbook of Practical Chemistry,Prashant Publications. ▪ Patel, H. N., Turakhia, S. P., Kelker, S. S., Puniyani, S.R., (2010), College Practical Chemistry, Himalaya Publishing House.	

T.Y. B.Sc. Chemistry (Elective)
Semester-VI
CHE-DSE-361A: Introduction to Analytical Instrumentations

Total Hours: 30 **Credits: 2**

Course objectives	▪ To get the knowledge of basic concept of analytical Chemistry. ▪ To study the Gas chromatography. ▪ To learn the methods of Ion exchange chromatography. ▪ To understand, clinical chemistry and its analyzing methods.	
Course outcomes	After successful completion of this course, students are expected to ▪ learn the basic concept of analytical chemistry. ▪ understand method involving gas chromatography. ▪ get the knowledge of ion exchange chromatography. ▪ understand methods involving analysis of clinical chemistry.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Analytical chemistry** Role of analytical chemistry, Types of analysis, Classification of analytical methods, Selecting an analytical method, Factors affecting the analytical methods, Safety in the analytical laboratory, Selecting and handling of reagents.	**8**
Unit II	**Gas Chromatography** Introduction, Principles, Gas chromatography columns, Gas chromatography Detectors, Column efficiency in chromatography-Theoretical plates, Van Deemter equation, Capacity factor and resolution, Problems.	**8**
Unit III	**Ion Exchange Chromatography** Introduction, Cation Exchange Resins, Anion Exchange Resins, Effect of pH - Separation of Amino Acids, Effect of Complexing Agents - Separation of Metal ions on anion exchange columns, Applications of ion exchange chromatography.	**7**
Unit IV	**Clinical Chemistry** Composition of blood, Collection and preservation of samples, Storage of blood samples, Clinical analysis: Estimation of blood glucose, Estimation of	**7**

	blood urea, Estimation of total serum protein (Biuret method of Reinhold).	
Study References	▪ Christian Gary D.(2015), Analytical Chemistry 6th edition, Wiley publication, Satyam enterprises, Delhi. ▪ Sharma B. K., (2012), Instrumental methods of chemical analysis 28th edition, GOEL publishing house, Krishna Prakashan media Ltd., Meerut, India. ▪ Willard, H. H., (1986), Instrumental Methods of Analysis, CBS Publishers, New Delhi. ▪ Skoog D. A., West D. M. and Holler F. J., (1992), Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth,Texas. ▪ Gupta Alka L., (2017), Analytical chemistry 8th edition, PragatiPrakashan, Meerut. ▪ Dean, J. A., (1992) Analytical Chemistry Notebook, McGraw Hill, New York. ▪ Vogel, A. I., (1996), Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, NewYork. ▪ Chatwal G.&Anand S. (2019). Instrumental Methods of Chemical Analysis, 5th edition Himalaya publications, Mumbai.	

T.Y. B.Sc. Chemistry (Elective)
Semester-VI
CHE-DSE-361B: Industrial Inorganic Chemistry

(NPTEL Course code: noc22-cy13)

Total Hours: 30 **Credits: 2**.

Course objectives	▪ To get the knowledge of basic concept of analytical Chemistry. ▪ To study the Gas chromatography. ▪ To learn the methods of Ion exchange chromatography. ▪ To understand, clinical chemistry and its analyzing methods.	
Course outcomes	After successful completion of this course, students are expected to ▪ learn the basic concept of analytical chemistry. ▪ understand method involving gas chromatography. ▪ get the knowledge of ion exchange chromatography. ▪ understand methods involving analysis of clinical chemistry.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Industrial Inorganic Chemistry** Introduction; Importance of the chemical industry; Primary inorganic materials; Bulk and comodities chemicals; Fine and speciality chemicals; Water and hydrogen; H2O2 and inorganic peroxido compounds. Nitrogen and nitrogen compounds; Phosphorus and its compounds; Sulfur and sulfur compounds. Halogen and halogen compounds; Applications of iodine and iodine compounds.	**8**
Unit II	**Mineral fertilizers and Metals** Nitrogen fertilizers, ammonium nitrate and urea; Phosphorous containing fertilizers. Potassium containing fertilizers; Economic importance of fertilizers Metals and their compounds; Metallic lithium and its compounds; Metallic sodium, sodium borates; Potassium and its compounds, KOH and K2CO3.	**8**
Unit III	**Alkaline earth metals and its compounds** Beryllium and magnesium; Calcium, strontium and barium; Manganese, manganese compounds and their applications Industry important organo-silicon compounds, industrial silicone products. Inorganic solid, zeolites and catalysts, inorganic fibers; Construction materials; Enamel and ceramics.	**7**

Unit IV	**Carbon modifications, Fillers and Inorganic pigments** Carbon modifications, diamond, graphite, carbonization and graphitization; Glassy and foamed carbon; carbon black. Fillers - synthetic and natural, applications; Metallic hard materials. Inorganic pigments; TiO_2, lithopone, ZnS, ZnO and Fe_2O_3; Corrosion protection pigments; Luminescent and magnetic pigments; Conclusions.	**7**
Study References	▪ Büchel, K. H., Moretto, H. H., & Werner, D. (2008). Industrial inorganic chemistry. John Wiley & Sons. ▪ Swaddle, T. W. (1997). Inorganic chemistry: an industrial and environmental perspective. Elsevier.	

T.Y. B.Sc. Chemistry (Elective)
Semester VI
CHE-DSE-362 A: Practicals on Organic Chemistry-II

Total Hours: 60 **Credits: 2**

Course Objectives	• To study different types of organic reactions. • To develop skills required in chemistry such as the appropriate handling of apparatus and chemicals. • To learn the laboratory skills needed to design, safely conduct and interpret chemical research. • To expose the students to an extent of experimental techniques using modern instrumentation.	
Course Outcomes	Students will be able to: • Develop skill to carry out chemical reactions on laboratory scale. • Understand mechanisms involved in Chemical Reaction. • Understand various purification techniques. • To carry out estimations of organic compounds.	
Sr. No.	**Particular Topic**	**Hours**
A	**Single Stage Preparations (Minimum Seven)**	
1	p-nitro acetanilide from Acetanilide (Nitration)	
2	Benzoic acid from benzamide (Hydrolysis method)	04
3	Benzoquinone from Hydroquinone (Oxidation by $KBrO_3$ or $K_2Cr_2O_7$)	04
4	p-Iodonitrobenzene from p-Nitroaniline (Sandmeyer Reaction)	04
5	m- Nitro aniline from m-Dinitrobenzene (Reduction)	04
6	Benzoic acid from Ethyl benzoate (Ester hydrolysis)	04
7	p-bromoacetanilide from acetanilide (Bromination)	04
8	m-dinitrobenzene from nitrobenzene by Nitration	04
9	Iodoform from ethanol by Halogenation.	04
10	Benzanilide from aniline by Benzoylation.	04
B	**Organic Estimations (Minimumfour)**	
11	To estimate basicity of given acid sample	04
12	To determine the amount of glycine present in the given unknown solution.	04
13	To estimate amount of glucose in the given solution.	04
14	To estimate the amount of Nitro group in the given organic compound	04
15	Estimation of the amino group in given liquid.	04
16	Estimation of Ascorbic acid by Iodine solution.	04
C	**Structural Elucidation of simple organic compounds from its UV, IR and ^{1}H NMR spectrum (Any four)**	
17	Structural Elucidation of organic compounds from its spectrum	04
18	Structural Elucidation of organic compounds from its spectrum	04
19	Structural Elucidation of organic compounds from its spectrum	04
20	Structural Elucidation of organic compounds from its spectrum	04

Study Resources	• Vogel A. I., (2005), Practical Organic Chemistry, 5th Edition Pearson. New York • Agarwal O. P., (2014), Practical Organic Chemistry, Krishna Prakashan Media (P) Ltd, Meerut, India • Kamboj P. C., (2013,) University Practical Chemistry, 1st (Reprint) Edition, Vishal Publishing Co. Jalandhar, India • Ahluwalia V. K. and Aggarwal Renu, (2016), Comprehensive Practical Organic Chemistry-Qualitative Analysis Universities Press, Hyderabad, India • Woodward R.B. and Baer H., J. Am. Chem. Soc. 1948, 70, 1161. • Rideout D. C. and Breslow R., J. Am. Chem. Soc. 1980, 102, 7816. • Anastas, P.T and Warner, J.C (1998), Green Chemistry: Theory and Practice, J.C. Oxford University Press. New York • Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST Page 69 of 70, India • Williams D. H. & Fleming I., (2007), Spectroscopic Methods in Organic Chemistry, 6th Ed.McGraw-Hill Education, Europe, Middle East & Africa. • Kalsi P. S., (2007), Spectroscopy of Organic Compounds, 6thEd, New Age Int. Pub. India • Silverstein R. M. and Webster F. X., (2007) Spectrometric Identification of Organic Compounds, 7th Edition, John Wiley and Sons Inc, NJ. • Pavia Donald L., Lampman Gary M., Kriz George S. and Vyvyan J. R., (2015), Introduction to Spectroscopy, 5th edition. Indian Edition. Cengage Learning, Australia, Brazil, Mexico, Singapore, United Kingdom, United States. • Sharma Y. R. Elementary Organic Spectroscopy, (2013), 5th Ed. S Chand & Company. New Delhi. • Jag Mohan Organic Spectroscopy (2001), Narosa Publishing House, New Delhi	

T.Y. B.Sc. Chemistry (Elective)
Semester-VI
CHE-DSE-362B: Practicalon Analytical Chemistry-II

Total Hours: 60 **Credits: 2**

Course objectives	▪ To provide foundational knowledge of analytical chemistry techniques such as titration, gravimetric analysis, chromatography, and spectroscopy. ▪ To develop hands-on skills in laboratory procedures for the preparation, handling, and analysis of samples. ▪ To ensure familiarity with key instruments such as pH meters, spectrophotometers, and chromatographs. ▪ To instill an understanding of analytical problem-solving by applying various methods to qualitative and quantitative analyses.	
Course Outcomes	After successful completion of this course, students are expected to ▪ Demonstrate proficiency in volumetric and gravimetric analysis techniques for accurate determination of chemical composition. ▪ Apply chromatographic techniques such as paper chromatography, thin-layer chromatography to separate and identify components of mixtures. ▪ Utilize spectrophotometric methods to determine the concentration of analytes in various samples by applying the Beer-Lambert law. ▪ Measure pH, buffer capacity, and conductance of solutions, demonstrating an understanding of their chemical and practical significance.	
Sr. No.	**Contents (Any 15)**	**Hours**
1	To prepare a standard solution and use it for accurate volumetric analysis.	**4**
2	To determine the strength of an unknown acid solution using acid-base titration.	**4**
3	To standardize a sodium hydroxide solution using potassium hydrogen phthalate as a primary standard.	**4**
4	To determine the percentage of sodium carbonate in a given sample.	**4**

5	To determine the amount of sulfate in a given sample gravimetrically.	**4**
6	To analyze the purity of a barium salt by precipitation and gravimetric estimation of barium sulfate.	**4**
7	To estimate the amount of nickel in a solution by gravimetric analysis using dimethylglyoxime (DMG).	**4**
8	To separate a mixture of amino acids using paper chromatography and identify them based on their R_f values.	**4**
9	To separate and identify the components of a mixture using thin-layer chromatography (TLC).	**4**
10	To study the efficiency of gas chromatography in separating a mixture of volatile organic compounds.	**4**
11	To demonstrate the principles of column chromatography by separating pigments from spinach extract.	**4**
12	To prepare buffer solutions of known pH and verify their pH using a pH meter.	**4**
13	To determine the pH of a given solution using a pH meter and universal indicator.	**4**
14	To analyze the effect of dilution on the pH of a weak acid and a strong acid.	**4**
15	To determine the strength of an acid solution by conductometric titration.	**4**
16	To determine the concentration of ferrous ions in a solution using potassium permanganate by redox titration.	**4**
17	To analyze the chloride content in a water sample using Mohr's method.	**4**
18	To study the conductance of electrolytes and verify the variation with concentration.	**4**
19	To analyze the iron content in a given sample using spectrophotometry.	**4**
20	To analyze the amount of hydrogen peroxide in a solution using potassium permanganate.	**4**
Study	▪ Quantitative Chemical Analysis" by Daniel C. Harris, W. H. Freeman	

Resources	and Company 9th Ed (2016). ▪ Vogel's Textbook of Quantitative Chemical Analysis" by G. H. Jeffery, J. Bassett, J. Mendham, and R. C. Denney, Pearson Education, 6th Ed (2000). ▪ Fundamentals of Analytical Chemistry" by Douglas A. Skoog, Donald M. West, F. James Holler, Cengage Learning, 9th Ed (2013). ▪ Analytical Chemistry Handbook" by Gary D. Christian, McGraw-Hill Education 2nd Ed (2003). ▪ Practical Manual of Analytical Chemistry" by S. R. Kanetkar and K. T. Shinde, Pragati Books Pvt. Ltd. ▪ Laboratory Experiments in General Chemistry" by W. L. Masterton and C. N. Hurley, Cengage Learning, 13th Ed(2015). ▪ Experiments in General Chemistry" by C. M. Berresford and J. R. Campbell, Brooks Cole (Cengage Learning), 9th Ed (2006).

T.Y. B.Sc. Chemistry (Vocational)
Semester-VI
CHE-VSC-361: Aspects of Industrial Chemistry

Total Hours: 30 **Credits: 2**

Course Objectives	• To enhancetechnical and practical skills in chemistry, focusing on real-world industrial applications with basic requirementsof industry and Copyright act, Patent Act and Trademarks. • To study the chemical reactions involved in transforming raw sugarcane into refined sugar. • To study the chemical processes used in soaps and detergent manufacturing. • To study the role of Chemistry in developing safe, effective, and appealing cosmetic products and how fragrance chemistry plays a vital role in creating perfumes	
Course Outcomes	After successful completion of this course, students are expected to: • understand the basic requirement and importance of patent, trade-marks, copyright act in various industries. • understand the reactions involved in of sugar preparation and study of waste management with recycling. • understandcompositions of soaps and detergents based on the desired properties such as foaming, cleaning efficiency, and skin compatibility. • To acquire knowledge and skill of preparation of Hair dye, shampoo, talcum powder, nails enamel, shaving creams etc.	
Unit	**Contents**	**Hours**
Unit I	**Basics of Industrial Chemistry** Introduction, basic requirements of chemical industries, chemical production, raw materials, unit process and unit operations, Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copyright act, patent act, trademarks.	**7**
Unit II	**Chemistry of Sugar** Introduction, Sugar Industry in Maharashtra and India, Manufacture of Cane Sugar- [Refining (with flow sheet)], General Idea of Sulphitation and Carbonation, Concentration /Evaporation, Crystallization Separation of	**7**

	crystals. Grades, Baggase, Cellotex.	
Unit III	**Chemistry of Soap and Detergents** Soaps, Surfactants and its Importance, Raw Materials used in Soap Manufacture, Manufacture of Soaps (Continuous Process), Cleansing action of Soap, Classification of Soaps, Detergents, Principal group of Synthetic Detergents, Detergents builders and Additives, Comparison between Soap Detergent	**8**
Unit IV	**Chemistry of Perfume and Cosmetics** **A. Perfume:**1) Introduction of Essential oils 2) Properties, Uses and Importance of - essential oils in cosmetic industries with reference to --- i) Eugenol ii) Geraniol iii) Sandalwood oil iv) Eucalyptus v) Rose oil vi) 2-phenyl ethyl alcohol vii) Jasmone viii) Civetone ix) Muscone x) Antiperspirants and Artificial flavours. **B. Cosmatics:**Preparation, Properties of good cosmetics and uses of Hair dye, shampoo, suntan lotions, lipsticks, creams (cold and shaving creams).	**8**
Study Resources	• Sharma B. K., (2011), Industrial Chemistry, 16th Edition, Goel Publishing House, Meerut, (U.P.), India. • Austin G. T.,(1984), Shreve's Chemical Process Industries, 5th Edition, McGraw Hill, New York. • Clausen III Chris A and Mattson Guy, (1978), Principles of Industrial Chemistry, John Wiley and Sons, Inc. Somerset, New York. • More P.G., (2010), Comprehensive Industrial Chemistry, 1st Edition, PragatiPrakashan, Meerut (U.P.), India. • AIi Mohammad Farhat, El AIi Bassam M., Speight James G., (2005), Handbook of Industrial Chemistry: Organic Chemicals, The McGraw-Hill Education, India. • Kent Jems A., (1997), Riegel`s Handbook of Industrial Chemistry, 9th Edition, CBS Publishers and Distributors, Delhi. • Das R.K., (1976), Industrial Chemistry ,2nd Edition, Asia Publishing Mumbai. • Noble E., (1998), Dyes & Paints: A Hands-On Guide to Coloring Fabric, Fibre Studio Press, USA.	

T.Y. B.Sc. Chemistry (Vocational)
Semester-VI
CHE-VSC-362: Practical on Industrial Chemistry

Total Hours: 60 **Credits: 2**

Course Objectives	• The course aims to prepare students for a career in industry, research, or academia. • To develop hands-on skills in laboratory techniques, including distillation, crystallization, and synthesis. • To analyze and characterize organic compounds using various spectroscopic and chromatographic techniques • To develop synthetic route according to targeted compounds.	
Course Outcomes	After successful completion of this course, students are expected to: • Demonstrate proficiency in advanced organic synthesis techniques and laboratory practices. • Apply distillation and crystallization techniques for purifying organic compounds. • Prepare soap through the saponification reaction, demonstrating knowledge of ester hydrolysis. • Successfully synthesize targeted molecule and understand its application.	
Sr. No.	**Contents**	**Hours**
1	Purification of organic compounds by using distillation and crystallization methods.	**4**
2	Preparation of soap using saponification	**4**
3	To prepare perfumery material oil of wintergreen (methyl Salicylate)	**4**
4	To prepare perfumery material Ethyl Benzoate	**4**
5	Synthesis of Benzocaine (Anaesthetics drug)	**4**
6	To prepare azo dyes from primary aromatic amine	**4**
7	Synthesis of industrial compounds: 4 – bromoaniline/4-Nitro aniline.	**4**
8	Synthesis of common industrial compounds: 4- Aminobenzoic acid/ 4-Nitrobenzoic acid	**4**
9	Paper Chromatograpic separation of ions./Thin layer separation of compounds.	**4**
10	Spectrophotometric estimation of drugs – ciprofloxacin, paracetamol, etc	**4**
11	To prepare urea formaldehyde or phenol formaldehyde resins.	**4**
12	Determination of saponification value of oil.	**4**
13	Determination of iodine value of fat.	**4**
14	Isolation of casein from milk	**4**
15	Functional group identification from Infrared spectra	**4**
Study Resources	• J. Singh, (2014), Advanced Practical Chemistry, 5th edition. PragatiPrakashan, New Delhi. • Sharma B. K., (2011), Industrial Chemistry, 16th Edition,	

	GoelPublishing House, Meerut, (U.P.), India. • Vogel, I. (1974). Practical Organic Chemistry. Longman, USA. • Kent Jems A., (1997), Riegel`s Handbook of Industrial Chemistry, 9th Edition, CBS Publishers and Distributors, Delhi.	

Skills acquired and Job prospects for the Chemistry students

Skills Acquired and Job Prospects for B.Sc. Chemistry Students

Skills Acquired:

1. **Scientific and Analytical Skills**
    - BSc Chemistry students develop good analytical skills through laboratory work, where they learn to conduct experiments, interpret data, and troubleshoot issues. They become proficient in using various scientific apparatus and techniques to test hypotheses and analyze chemical compounds.
2. **Problem-Solving and Critical Thinking**
    - Chemistry students are trained to approach problems systematically, developing a keen ability to analyze situations, identify issues, and apply appropriate solutions. This skill is vital in both research and industrial applications.
3. **Laboratory Techniques and Equipment Handling**
    - Students gain hands-on experience in using a variety of laboratory instruments such as pippet, burrate, beakers, thermometer, electronic balance and titration equipment. These practical skills are highly valued in research and manufacturing industry.
4. **Research and Data Interpretation**
    - Chemistry students learn how to perform experiments, collect and analyze data followed by interpretation of results. They are also introduced to some computer tools like chemdraw, ms excel that help them in making data analysis and presentation .
5. **Communication Skills**
    - Chemistry students develop both written and verbal communication skills.
    - Effective communication is vital in chemistry, whether it's reporting findings through research papers, creating presentations, or collaborating with interdisciplinary teams. BSc Chemistry students develop both written and verbal communication skills.
6. **Knowledge of Chemical Principles**
    - Students acquire in-depth knowledge of chemical principles, including organic, inorganic, physical, and analytical chemistry. They also gain an understanding of environmental chemistry, biochemistry, and industrial chemistry.
7. **Attention to Detail**
    - The precise nature of chemical work requires students to develop a high level of attention to detail, ensuring accuracy in experiments, measurements, and reporting.
8. **Time Management**
    - Balancing laboratory sessions, coursework, and exams helps students improve their time management skills, a key asset in both academic and professional environments.

Job Prospects:

1. **Research and Development (R&D)**

- BSc Chemistry graduates can work in R&D departments of various industries, including pharmaceuticals, biotechnology, environmental science, and materials science. Roles in this field include research chemists, lab technicians, and product development specialists.

2. **Pharmaceutical and Biotechnology Industries**
   - Graduates often find positions in drug development, quality control, and manufacturing. Roles like pharmaceutical chemist, formulation scientist, and biochemist are in demand, as there is constant growth in the healthcare sector.
3. **Environmental Chemistry and Sustainability**
   - With a rising emphasis on environmental conservation, chemistry graduates can work as environmental analysts, waste management specialists, or sustainability officers. These roles involve monitoring environmental pollution and developing eco-friendly technologies.
4. **Forensic Science**
   - Graduates with an interest in crime scene investigation may pursue careers as forensic chemists, where they analyze physical evidence for criminal cases. This field combines chemistry with law enforcement.
5. **Chemical Engineering and Manufacturing**
   - Graduates can enter the chemical engineering industry, working in chemical plants, refineries, or manufacturing facilities. Roles include process engineer, quality control manager, and safety officer.
6. **Teaching and Academia**
   - BSc Chemistry students who enjoy teaching may pursue a career in education, becoming chemistry teachers or lecturers at high school or university levels. They can also continue their studies to earn a master's or PhD for further academic pursuits.
7. **Sales and Marketing for Chemical Products**
   - Some graduates may transition into the business side of the chemical industry, working as sales representatives or marketing specialists for chemical products, laboratory equipment, or pharmaceuticals.
8. **Government and Regulatory Agencies**
   - Careers in governmental organizations or regulatory bodies such as the Environmental Protection Agency (EPA), Food and Drug Administration (FDA), or Occupational Safety and Health Administration (OSHA) are viable for chemistry graduates interested in policy-making and compliance roles.
9. **Quality Control and Testing**
   - Many industries require chemists to ensure the quality of products, especially in sectors like food and beverages, cosmetics, and consumer goods. These roles often involve performing chemical tests and ensuring products meet safety standards.

In conclusion, BSc Chemistry graduates acquire a versatile set of skills that open the door to numerous career paths in research, industry, teaching, and regulatory roles. The demand for chemistry professionals is expected to remain strong, with opportunities in emerging fields like renewable energy, biotechnology, and environmental sustainability.