SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved Meerut

Ordinance No. :- V-126-B-43

(Approved in Academic council meeting held on 11.03.2026

Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus

of

B.Sc. CHEMISTRY

FOUR – YEAR UNDER GRADUATE

PROGRAM

(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand

SUBHARTI UNIVERSITY

Meerut

Effective from 2025-2026

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

PROGRAMME OBJECTIVES (POs)

AIMS OF BACHELOR'S DEGREE PROGRAMME IN CHEMISTRY

The broad aims of bachelor's degree programme in Chemistry are:

The aim of bachelor's degree programme in chemistry is intended to provide:
(i) Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles, and theories.

(ii) To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.

(iii) To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self - employment/entrepreneurship.

(iv) To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects.

(v) To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry graduates as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.

(vi). To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.

(vii) To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

PROGRAM OUTCOMES (POs)

The student graduating with the Degree B.Sc. (Honours/Research) in Chemistry should be able to understand:

PO-1 **Core competency:** Students will acquire core competency in the subject Chemistry, and in allied subject areas.

PO-2 Systematic and coherent understanding of the fundamental concepts in Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, and all other related allied chemistry subjects.

PO-3 Students will be able to understand use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

PO-4 The students will be able to understand the characterization of materials.

PO-5 Students will be able to understand the basic principle of equipment, instruments used in the chemistry laboratory.

PO-6 Students will be able to understand / demonstrate the experimental techniques and methods of their area of specialization in Chemistry.

PO-7 **Disciplinary knowledge and skill**: A graduate student are expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.

PO-8 **Skilled communicator**: The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

PO-9 **Critical thinker and problem solver**: The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

PO-10 **Skilled project manager**: The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

PO-11 **Ethical awareness/reasoning**: A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.

PO-12 **Lifelong learner:** The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

Semester-Wise Titles of the Major Course (MJC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory / Practical	Credits
1	I	BSCY-101	Atomic Structure, Chemical Bonding and Redox Reactions	Theory	04
		BSCY-101P	Practicals - I (Major 1)	Practical	02
	II	BSCY-201	Organic Basics and Hydrocarbons	Theory	04
		BSCY-201P	Practicals-II (Major 2)	Practical	02
2	III	BSCY-301	Functional Groups Containing X, O , S & N	Theory	03
		BSCY-304P	Practicals-III (Major 3)	Practical	02
		BSCY-302	States of Matter and Concept of Equilibria	Theory	04
	IV	BSCY-401	s, p , d and f Block Elements and Coordination Chemistry	Theory	04
		BSCY-402	Chemical Thermodynamics and Applications	Theory	04
		BSCY-405P	Practicals- IV (Major 5 + 6)	Practical	02
		BSCY-403	Reaction Mechanisms in Organic Chemistry	Theory	05
3	V	BSCY-501	Analytical Chemistry	Theory	04
		BSCY-502	Phase Equilibria, Chemical Kinetics & Surface Chemistry	Theory	04
		BSCY-506P	Practicals -V (Major 8 + 9)	Practical	02
	VI	BSCY-601	Organometallic and Bioinorganic	Theory	04

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			Chemistry		
		BSCY-602	Electrochemistry	Theory	04
		BSCY-603	Polymer and Materials Chemistry	Theory	04
		BSCY-606P	Practicals -VI (Major 11+12)	Practical	02
4	**VII**	BSCY-701	Reaction Mechanisms and Electronic Spectra in Inorganic Chemistry	Theory	05
		BSCY-702	Molecular Spectroscopy and Photochemistry	Theory	03
		BSCY-705P	Practicals - VII (Major 14)	Practical	02
		BSCY-703	Heterocyclics and Biomolecules	Theory	04
		BSCY-706P	Practicals- VIII (Major 15)	Practical	02
	VIII	BSCY-801	Quantum and Nanochemistry	Theory	04

Semester-Wise Titles of the Minor Course (MIC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	**I**	BSCY-102	Nuclear and Environmental Chemistry	Theory	03
	II	BSCY-202	Inorganic Materials of Industrial Importance	Theory	03
2	**III**	BSCY-303	Industrial Chemicals and Environment	Theory	03
	IV	BSCY-404	Applied Organic Chemistry	Theory	03
3	**V**	BSCY-503	Polymer Chemistry	Theory	03
		BSCY-504	Introduction to Green Chemistry	Theory	03
	VI	BSCY-604	Applications of Computers in Chemistry	Theory	03
		BSCY-605	Quality Assurance and Control	Theory	03
4	**VII**	BSCY-704	Research Methodology	Theory	04
	VIII	BCY-802	Research Publications and Ethics	Theory	04

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Semester-Wise Titles of the Multidisciplinary Course (MDC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	M-DIS-FCP	Chemistry of Foods, Cosmetics and Perfumes	Theory	03
	II	M-DIS-EL	Chemistry in Everyday Life	Theory	03
2	III	M-DIS-IMC	Introduction to Material Chemistry	Theory	03

Semester-Wise Titles of the Skill Enhancement Course (SEC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	SEC- FP	Fuel and Pharmaceutical Chemistry	Theory	03
	II	SEC-WTA	Water Treatment and Analysis	Theory	03
2	III	SEC- EC	Elementary Computer Application Software	Theory	03

Semester-wise Titles of the Value Added Course (VAC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	VAC-RB	Rashtra bodh	Theory	03
	II	VAC-IKS	IKS	Theory	03

Semester-Wise Titles of the Ability Enhancement Course (AEC) Papers in B.Sc. (Chemistry)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	AEC-01	English Communication Skill	Theory	02
	II	AEC-02	Environmental Science	Theory	02
2	III	AEC-03	Course on Disaster Risk Management	Theory	02
	IV	AEC-04	Course on NCC/NSS/NGO'S/SCOUT GUIDE/SPORTS	Theory	02

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KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Chemistry

UG Course offered by Department of Chemistry, (Session 2025-26 onwards)

		I	II	III	IV	V	VI	VII	VIII	Total
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	20	20	20	20	20	20	20	20	160

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Department of Chemistry												
Course Name - B.Sc. Chemistry												
Batch:2025 -26							SEM:I					
S.No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total
				L	T	P						
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)	
1	Major 1 (Theory)	BSCY-101	Atomic Structure, Chemical Bonding and Redox Reactions	4	0	0	4	5	10	15	70	100
2	Practicals-I (based on Major 1)	BSCY-101P	Practical-1	0	0	4	2	5	10	15	70	100
3	Minor 1	BSCY-102	Nuclear and Environmental Chemistry	3	0	0	3	5	10	15	70	100
4	Multi Disciplinary	M-DIS-FCP	Chemistry of Foods, Cosmetics and Perfumes	3	0	0	3	5	10	15	70	100
5	Ability Enhancement Course	AEC-01	English Communication Skill	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course	SEC-FP	Fuel and Pharmaceutical Chemistry	3	0	0	3	5	10	15	70	100
7	Value Added Course	VAC-HW	Health and Wellness	3	0	0	3	5	10	15	70	100
8	IKS / Rastra bodh	VAC-RB		2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							20	35	70	105	490	700

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Department of Chemistry												
B.Sc. Chemistry												
Batch:2025 -26							**SEM:II**					
S.No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**
				L	**T**	**P**						
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**	
1	Major 2 (Theory)	BSCY-201	Organic Basics and Hydrocarbons	4	0	0	4	5	10	15	70	100
2	Practicals -II (based on Major 2)	BSCY-201P	Practicals-II	0	0	4	2	5	10	15	70	100
3	Minor 2	BSCY-202	Inorganic Materials of Industrial Importance	3	0	0	3	5	10	15	70	100
4	Multi Disciplinary 2	M-DIS-EL	Chemistry in Everyday Life	3	0	0	3	5	10	15	70	100
5	Ability Enhancement Course 2	AEC-02	Environmental Science	2	0	0	2	5	10	15	70	100
6	Skill Enhancement Course 2	SEC-WTA	Water Treatment and Analysis	3	0	0	3	5	10	15	70	100
7	Value Added Course 2	VAC-SF	Sports and Fitness	3	0	0	3	5	10	15	70	100
8	IKS / Rashtra bodh	VAC-IKS		2	0	0	2	5	5	10	30	50
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**

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Detailed Syllabus

Major Courses

Programme / Class: Undergraduate Certificate	**Year**: First	**Semester**: First
Subject: CHEMISTRY		
Course Code: BSCY-101	**Course Title**: Atomic Structure, Chemical Bonding and Redox Reactions	

Course Objectives:

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

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table, physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. Atomic theory of matter, composition of atom.
6. Defining isotopes, isobar and isotone.
7. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
8. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.

Course Outcomes:

On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table.
2. Predicting structure of molecules.
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70=100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures
I	**Atomic Structure** Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ 2. Quantum numbers and their significance. Normalized and orthogonal wave	

	functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	
II	**Periodicity of Elements** s, p, d, f -block elements, the Long form of Periodic Table. Detailed discussion of the following properties of the elements. a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. b) Atomic radii (van der Waals) c.) Ionic and crystal radii. d.) Covalent radii (octahedral and tetrahedral) e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. f) Electron gain enthalpy, trends of electron gain enthalpy. g) Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity.	
III	**Chemical Bonding** **(i) lonic bond** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation, Madelung constant, expression for lattice energy, Kapustinskii equation. Born-Haber cycle and its application, Solvation energy. **(ii) Covalent bond** Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules: N2, O2, C2, B2, F2, CO, NO, and their ions. Covalent character in ionic compounds; polarization, polarizing power and polarizability. Fajan rules. Ionic character in covalent compounds: Bond moment and dipole moment, ionic character from dipole moment and electronegativities. **(iii) Metallic Bond** Qualitative idea of free electron model, Semiconductors, Insulators.	

	(iv) Weak Chemical Forces Van der Waals, ion-dipole, dipole-dipole, induced dipole, dipole-induced dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.	
IV	**Oxidation-Reduction and general principle of metallurgy** Redox equations, Balancing by Ion electron method & Oxidation number method. Disproportionation Reaction. Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Pyrometallurgy, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel de Boer process and Mond's process, Zone refining.	

SUGGESTED READINGS:

1. Lee, J. D. Concise Inorganic Chemistry, Wiley, 5th Edn .
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry, (Third Edition) John Wiley & Sons,1999.
3. Atkins, P. W. and De Paula, J. Physical Chemistry, Tenth Edition, Oxford University Press, 2014.
4. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning, 2002.
5. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994. 6. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
6. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010

Components for Continuous Internal Assessment (CIA) for theory course:	15 Marks
-One Mid Semester Written Test (1x15):	10 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	05 Marks
-Attendance & Conduct:	30 Marks
-Total	

Subject Code: BSCY-101P	Practical -I	2 Credits

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1. Titrimetric Analysis:

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality.

2. Acid-Base Titrations: Principles of acid-base titrations to be discussed.

(i) Estimation of oxalic acid using standardized NaOH solution

(ii) Estimation of sodium carbonate using standardized HCl.

(iii) Estimation of carbonate and hydroxide present together in a mixture.

(iv) Estimation of carbonate and bicarbonate present together in a mixture.

3. Redox Titration: Principles of oxidation-reduction titrations to be discussed.

(i) Estimation of oxalic acid using standardized KMnO4 solution

(ii) Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.

(iii) Estimation of oxalic acid and sodium oxalate in a given mixture**.**

SUGGESTED READINGS:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

2. Harris, D. C.; Lucy,C. A.(2016), Quantitative Chemical Analysis, 9th Edition, Freeman and Company.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Certificate	**Year**: First	**Semester**: Second
Subject: CHEMISTRY		
Course Code: BSCY-201	**Course Title**: Organic Basics and Hydrocarbons	

Course Objectives:

On successful completion of this course the student should be able to understand:

1. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and their nomenclature.
3. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
4. Reactivity, stability of organic molecules, structure, stereochemistry.
5. Mechanism of organic reactions (effect of nucleophile/ leaving group, solvent), substitution vs. elimination.

Course Outcomes:

On successful completion of this course the student should know:

1. Design and syntheses of organic molecules.
2. Correlation of Reactivity, stability of organic molecules, structure, stereochemistry.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials Practical (in hours per `week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (45)
I	**Basic Concepts of Organic Chemistry** Electronic displacements and their applications: inductive, electromeric, resonance and mesomeric effects and hyperconjugation. Dipole moment, acidity and basicity. Homolytic and heterolytic fissions with suitable examples. Types, shape and relative stability of carbocations, carbanions, carbenes and free radicals. Electrophiles & nucleophiles, and introduction to types of organic reactions: addition, elimination and substitution reactions**.**	
II	**Stereochemistry** Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. specific rotation; Configuration and projection	

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	formulae: Newman, Sawhorse, Fischer and their interconversion. Chirality in molecules with one and two stereocentres; meso configuration. Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations (CIP rules). Geometrical isomerism: cis-trans, syn-anti and E/Z notations. Conformational Isomerism: Alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane). Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstitutedcyclohexanes.	
III	**Chemistry of Aliphatic Hydrocarbons:** **A. Alkanes:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Corey House Synthesis, Kolbe's Synthesis, Free radical substitutions: Halogenation - relative reactivity and selectivity. Lengthening and shortening of carbon chain in alkanes. **B. Alkenes & Alkynes:** Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cB reactions. Saytzeff and Hofmann eliminations, Pyrolytic eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration- demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction, Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Conversions involving π-bonds. **C. Aromatic Hydrocarbons:** Aromaticity: Aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups. **D. Polynuclear Hydrocarbons**: Reactions of naphthalene and anthracene: Structure, preparation and important derivatives of naphthalene and anthracene.	

SUGGESTED READINGS:

1. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. (2002), Organic C hemistry, Volume 1, 6th Edition, Dorling Kindersley (India)

Pvt. Ltd., Pearson Education.
3. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007) 3
4. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
5. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
6. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Subject Code: BSCY-201P	**Practical -II**	**2 Credits**

I **Acquaintance with Chemistry Laboratory**

1. Common Laboratory Apparatus Test tube, Beakers, Erlenmeyer flask, Volumetric flask, graduated cylinder, Pipette, Graduated pipette, Burette, Burette clamp. Funnel, Test tube holder, Bunsen burner, Glass rod, Utility clamp, Spot test plate, Tripod for Bunsen burner, Wash bottle, Spatula, Round-bottom flasks, Glass Condenser, Filter paper, Separatory funnel, Chemical balance, Furnaces etc.

2. Common Symbols of Laboratory Concerns Biohazard, Highly Flammable, Oxidizing, Corrosive, Harmful/Irritant, Radioactive, Explosive, Toxic, Dangerous for the Environment etc.

3. Common Laboratory Reagents Common Acids, Common Bases, Common Inorganic/Organic Salts, Organic Compounds, Common Solvents, Difference between Dilute/Concentrated/Fuming liquids.

4. Chemistry Laboratory Techniques Cutting, Bending & Rounding edge of glass tube & glass rods, fitting glassware's, fitting equipment for Fractional distillation, drawing liquids through pipette, burette & measuring cylinders, Diluting a solution to a known strength, Safe storage of chemicals.

II. Common Procedures

1. Heating/Boiling with and without condenser, Filtration techniques, Separation techniques, Crystallization techniques.

2. Purification of organic compounds (say naphthalene & others) by crystallization using the following solvents: a. Water b. Alcohol c. Alcohol-Water d. Acetone e. Hexane f. Toluene

3. Determination of the melting points a. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus) b. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds c. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method).

SUGGESTED READINGS:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: N.Delhi (2011). 4. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Department of Chemistry														
B.Sc. Chemistry														
Batch:2025 -26							SEM:III							
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment			External Assessment	Total	Remark
				L	T	P								
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)		End Sem Exam (70)		
1	Major 3 (Theory)	BSCY-301	Functional Groups Containing X, O , S & N	3	0	0	3	5	10	15		70	100	
2	Major 4 (Theory)	BSCY-302	States of Matter and Concept of Equilibria	4	0	0	4	5	10	15		70	100	
3	Minor 3	BSCY-303	Industrial Chemicals and Environment	3	0	0	3	5	10	15		70	100	
4	Multi Disciplinary 3	M-DIS-IMC	Introduction to Material Chemistry	3	0	0	3	5	10	15		70	100	
5	Ability Enhancement Course 3 (Disaster Risk Manage	AEC-03	Course on Disaster Risk Management	2	0	0	2	5	10	15		70	100	

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NH-58 Byepass Road, Meerut

	ment)												
6	Skill Enhancement Course 3	SEC-EC	Elementary Computer Application Software	3	0	0	3	5	10	15	70	100	
7	Practicals- III (based on Major 3)	BSCY-304P	Practicals-III	0	0	4	2	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**	

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Department of Chemistry														
B.Sc. Chemistry														
Batch:2025 -26							SEM:IV							
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark	
				L	T	P								
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)			
1	Major 5 (Theory)	BSCY-401	s, p , d and f Block Elements and Coordination Chemistry	4	0	0	4	5	10	15	70	100		
2	Major 6 (Theory)	BSCY-402	Chemical Thermodynamics and Applications	4	0	0	4	5	10	15	70	100		
3	Major 7 (Theory)	BSCY-403	Reaction Mechanisms in Organic Chemistry	5	0	0	5	5	10	15	70	100		
4	Minor 4	BSCY-404	Applied Organic Chemistry	3	0	0	3	5	10	15	70	100		
7	Practicals -IV (based on Major (5+6)	BSCY-405P	Practical - IV	0	0	4	2	5	10	15	70	100		
5	Ability Enhancement Course 3 (Course on NCC/NSS /NGO,s/ Scout Guide / Sports)	AEC-04A/ AEC-04B/ AEC-04C/ AEC-04D/ AEC-04E	Course on NCC/NSS/NGO'S/SCOUT GUIDE/SPORTS	2	0	0	2	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							20	30	60	90	420	600		

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Diploma	**Year**: Second	**Semester**: Third
Subject: CHEMISTRY		
Course Code: BSCY-301	**Course Title**: Functional Groups Containing X, O , S & N	

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Familiarization about classes of organic compounds and their methods of preparation.
2. Name reactions, uses of various reagents and the mechanism of their action.
3. Use of reagents in various organic transformation reactions.
4. Nitrogen containing functional groups and their reactions.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Elucidating reaction mechanisms for organic reactions.
2. Organometallic compounds and their uses.
3. Use of benzene diazonium salt in organic synthesis.

Credits: 3	**Core:** Compulsory
Max. Marks: 30 + 70=100	**Min. Passing Marks: 40**

Total No. of Lectures -Tutorials-Practical (in hours per week): **L-T-P:** 3-0-0

Unit	Topics	Total No. of Lectures (45)
I	**Chemistry of Halogenated Hydrocarbons:** Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc. Nucleophilic substitution vs. elimination. Aryl halides: Preparation from diazonium salts. nucleophilic aromatic substitution, SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li and their use in synthesis.	
II	**Alcohols, Phenols, Ethers and Epoxides:** Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3°- alcohols, Bouveault-Blanc Reduction, Preparation and properties of glycols and glycerol. Pinacol-Pinacolone rearrangement. Phenols: Preparation and properties, Acidic nature and factors affecting it, Ring substitution reactions, Reimer– Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism. Ethers and Epoxides: Preparation and reaction with acids. Reaction of epoxides with	

	alcohols, ammonia derivatives and LiAlH4.	
III	**Carbonyl Compounds:** Structure, reactivity and preparation of Carbonyl compounds. Nucleophilic additions, Nucleophilic additionelimination reactions with ammonia derivatives with mechanism. Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and BenzilBenzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, PDC and PGC), Addition reactions of unsaturated carbonyl compounds: Michael addition.	
IV	**Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids, Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids, Preparation and reactions of acid chlorides, anhydrides, esters and amides, Comparative study of nucleophilic substitution at acyl group, Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.	
V	**Chemistry of Active methylene groups**: Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	
VI	**Sulphur containing compounds**: Preparation and reactions of thiols, thioethers and sulphonic acids.	
VII	**Nitrogen Containing Functional Groups** Preparation and important reactions of aliphatic and aromatic compounds of nitro, nitrile and isonitrile groups. Amines: Effect of substituent and solvent on basicity, Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction, Distinction between 1°, 2° and 3°- amines with Heinsberg reagent and nitrous acid. Diazonium salts: Preparation and synthetic applications.	

SUGGESTED READINGS:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn. Pearson.
3. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
4. Solomons, T.W., Fryhle Craig, Organic Chemistry, John Wiley & Sons, Inc (2009).
5. Mc. Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition,

2013.
6. Kalsi, P. S. Organic reacations and their mechanisms, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., Organic Chemistry, Oxford University Press Inc., New York (2001).

Subject Code: BSCY-304P	**Practical - III**	**2 Credits**

I. Organic Chemistry

1. Detection of hetero elements in organic compounds.
2. Functional group test for nitro, amine and amide groups
3. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group
4. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)
5. Organic preparations:

a. Benzoylation of aniline
b. Oxidation of Benzaldehyde to benzoic acid.
c. Hydrolysis of amides and esters.
d. Preparation of Semicarbazone derivatives of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
e. Preparation of methyl orange.

II. Spot Analysis

a. Identification of chemicals by Spot tests.
b. Spot analysis of following Acid & Basic Radicals: $CO3^{2-,}$ Cl^{-} , NO^{3-} ,SCN^{-} , $SO4^{2-}$, $PO4^{3-,}$ NH^{4+} , Co^{2+}, Ni^{2+} , Fe^{3+}

SUGGESTED READINGS:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Khosla, B.D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). 4. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

Components for Continuous Internal Assessment (CIA) for practical course:	
	15 Marks
-One Mid Semester Written Test (1x15):	10 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	05 Marks
-Attendance & Conduct:	30 Marks
-Total	

K V Subharti College of Science
S V Subharti University
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Programme / Class: Undergraduate Diploma	**Year**: Second	**Semester**: Third
Subject : CHEMISTRY		
Course Code: BSCY-302	**Course Title**: States of Matter and Concept of Equilibria	

Course Objectives:

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

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Understanding Kinetic model of gas and its properties.
5. Maxwell distribution, mean-free path, kinetic energies.
6. Liquid state and its physical properties related to temperature and pressure variation.
7. Properties of liquid as solvent for various household and commercial use.
8. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
9. Ionic equilibria – electrolyte, ionization, dissociation.

Course Learning Outcomes:

On successful completion of this course the student shall know:

1. Determination of lattice parameters of given salt.
2. Study of X-Ray diffraction pattern. 3. Numerical related to salt hydrolysis, ionic equilibria.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 =100	**Min. Passing Marks: 40**

Total No. of Lectures -Tutorials-Practical (in hours per week) : **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (45)
I	**Behaviour of real gases**: Deviation from ideal gas behaviour, compressibility factor and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour. Boyle's temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states. Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, collision frequency, collision diameter, mean free path and viscosity of gases, their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η, variation of viscosity with temperature and pressure. Maxwell distribution and its use in	

	evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.	
II	**Liquid state:** Structure and physical properties of liquids, vapour pressure, surface tension, viscosity, and their dependence on temperature. Effect of addition of various solutes on surface tension, cleansing action of detergents.	
III	**Solid state:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices, X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.	
IV	**Equilibria-I:** Concept of Equilibrium. Le Chatelier's principle and its applications. Relationships between Kp, Kc and Kx for reactions involving ideal gases (Kinetic derivation). Equilibrium between ideal gases and a pure condensed phase. Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and tri-protic acids. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH of different salt solutions. Buffer solutions, Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product. Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) and applications of HSAB principle. Qualitative treatment of acid–base titration curves (calculation of pH at various stages). Theories of indicators, selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.	

SUGGESTED READINGS:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009). 5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
5. Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001 6 Commonly Asked Questions in Thermodynamics. CRC Press, 2011.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Diploma	**Year**: Second	**Semester**: Fourth
Subject: CHEMISTRY		
Course Code: BSCY-401	**Course Title**: s, p , d and f Block elements and Coordination Chemistry	

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Chemistry of s and p-block elements.
2. Chemistry of noble gases.
3. Structure, bonding of s and p block materials and their oxides/compounds.
4. Chemistry of boron compounds and their structures.
5. Chemistry of noble gases and their compounds, application of VSEPR theory in explaining structure and bonding.
6. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
7. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour
8. The nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
9. The transition metals stability in reactions, origin of colour and magnetic properties.
10. The separation of Lanthanoids and Actinoids, its colour, spectra and magnetic behaviour.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Extraction of metals through metallurgical operations and their uses.
2. Bonding of various s and p block elements.
3. Chemistry of inorganic polymers and their uses.
4. IUPAC nomenclature of coordination compounds/complexes.
5. Prediction of structure of complexes using various theories, colour and magnetic properties of different complexes. Use of lanthanide/actinide compounds in industries.
6.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures -Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Chemistry of s and p Block Elements** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides	

	and their classification: ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens.	
II	**Noble Gases:** Occurrence and uses, rationalization of inertness of noble gases, Clatharates; preparation and properties of XeF2, XeF4 and XeF6, Bonding in noble gas compounds (Valence bond and MO treatment for XeF2), Shape of noble gas compounds (VSEPR theory).	
III	**Elements:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bosworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excluding their metallurgy)	
IV	**Coordination Chemistry:** Werner's theory, EAN rule, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect. Valence bond theory (inner and outer orbital complexes), Crystal field theory (CFT), d-orbital splitting in weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d-orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Introduction to Ligand field theory (LFT) & Molecular Orbital Theory (MOT).	
V	**Lanthanides and Actinides:** Electronic configuration, oxidation states, colour, spectra and magnetic behaviour of lanthanides and actinides. Lanthanide contraction, separation of lanthanides (ion-exchange method only).	

SUGGESTED READINGS

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed. John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
6. Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

7. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
8. Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Diploma	**Year**: Second	**Semester**: Fourth
Subject: CHEMISTRY		
Course Code: BSCY-402	**Course Title**: Chemical Thermodynamics and Applications	

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. First & second laws of thermodynamics.
2. Concept of enthalpy & resonance energy.
3. Understanding the use of thermochemistry to calculate Bond energy.

Course Learning Outcomes:

On successful completion of this course the student should know the:

1. use of thermochemistry to calculate Bond energy
2. use of quantum chemistry in elucidation of atomic structure.
3. use of thermochemistry to calculate Bond energy..

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Basic Concepts of Chemical Thermodynamics** Intensive and extensive variables; state and path functions; isolated, closed and open systems.	

K V Subharti College of Science
S V Subharti University
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	Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule**.**	
II	**First law and Thermochemistry** Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.	
III	**Second Law** Concept of entropy; statement of the second law of thermodynamics, Carnot cycle. Calculation of entropy change for reversible and irreversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases). Relation between Joule- Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.	
IV	**Third Law** Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.	
VI	**Systems of Variable Composition** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases.	

SUGGESTED READINGS:

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L., A Textbook of Physical Chemistry, Vol 3, 5th Edition, McGraw Hill Education.

McQuarrie, D. A.; Simon, J. D. (2004), Molecular Thermodynamics, Viva Books Pvt. Ltd.

Components for Continuous Internal Assessment (CIA) for theory course: -One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks	
Subject Code: BSCY-405P	**Practical - IV**	**2 Credits**

I. Inorganic Preparations

a. Tetraamminecopper(II) sulphate, [Cu(NH3)4]SO4.H2O
b. Potassium tris(oxalate)ferrate(III)
c. Preparation of borax/ boric acid.
d. Cuprous Chloride, Cu2Cl2
e. Preparation of Aluminium potassium sulphate K2SO4Al2(SO4)3.12H2O (Potash alum)
f. Preparation of Chrome alum.

II. Thermochemistry

1. Determination of heat capacity of a calorimeter.
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.
4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

III. Equilibria:

Study the equilibrium of at least one of the following reactions by the distribution method:
(i) I2(aq) + KI→ KI3 (aq)
(ii) Cu2+(aq) + nNH3→ [Cu(NH3)n]2

SUGGESTED READINGS:

1. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
2. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
3. A. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
4. S. M. Khopkar, Environmental Pollution Analysis: New Age Int. Publisher, New Delhi. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

6. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8 th Ed.; McGraw-Hill: New York (2003).
7. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3 rd Ed.; W.H. Freeman & Co.: New York (2003).

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

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Programme / Class: Undergraduate Diploma	**Year: Second**	**Semester: Fourth**
Subject: CHEMISTRY		
Course Code: BSCY- 403	**Course Title**: Reaction Mechanisms in Organic Chemistry	

Course Objectives:

On completion of this course, the students will be able to understand

1. Reaction Mechanism and factors related with Structure and Reactivity.
2. Different types of substitution reactions.
3. Different types of Addition reactions in organic molecules
4. How Radical reactions are different from ionic reactions.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Factors affecting organic reactions and
2. Difference between reactions of aliphatic and aromatic reactions

Credits: 5	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 5-0-0

Unit	Topics
I	**Reaction Mechanism:** Structure and Reactivity : Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity, resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation. Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates, Steric LFER. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.
II	**Aliphatic Nucleophilic Substitution:** The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. Structural and electronic effects on SN1 and S N2 reactivity. Solvent effects. Kinetic isotope effects. Intramolecular assistance: Electron transfer nature of SN2 reaction. The neighbouring group mechanism, neighbouring group participation by R and π-bonds, anchimeric assistance. Classical and

	nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations. The SN i mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.
III	**Aliphatic Electrophilic Substitution**: Elecrophilic reactivity, general mechanism. Bimolecular mechanisms- SE2 and SE i. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. Kinetic of SE2-Ar reaction. Structural effects on rates and selectivity.
IV	**Addition to Carbon-Carbon Multiple Bonds**: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenartion of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.
V	**Addition to Carbon-Hetero Multiple Bonds**: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, Organozinc and Organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.
VI	**Aromatic Electrophilic Substitution** : The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.
VII	**Aromatic Nucleophilic Substitution** : The SNAr, SN1, benzyne and SRN1mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.
VIII	**Free Radical Reactions**: Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hundsdiecker reaction.

SUGGESTED READINGS:

1. Jerry March, Advanced Organic Chemistry-Reactions, Mechanism and Structure, John Wi1ey.
2. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Plenum.
3. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, Longman.
4. C. K. Ingold, Structure and Mechanism in Organic Chemistry, Cornell University Press.
5. R. T. Morrison and R. N. Boyd, Organic Chemistry, Prentice-Hall.
6. H. 0. House, Modern Organic Reactions, Benjamin.
7. R. 0. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Blackle Academic & Professional.
8. S. M. Mukherji, Pericyclic Reactions, Macmillan, India.
9. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan.
10. D. Nasipuri, Stereochemistry of Organic Compounds, New Age international.
11. P.S. Kalsi, Stereochemistry of Organic Compounds, New Age International.

Components for Continuous Internal Assessment (CIA) for theory course:	15 Marks
-One Mid Semester Written Test (1x15):	10 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	05 Marks
-Attendance & Conduct:	30 Marks
-Total	

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Department of Chemistry													
B.Sc. Chemistry													
Batch:2025 -26							SEM:V						
S.No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 8 (Theory)	BSCY-501	Analytical Chemistry	4	0	0	4	5	10	15	70	100	
2	Major 9 (Theory)	BSCY-502	Phase equilibria, Chemical Kinetics & surface Chemistry	4	0	0	4	5	10	15	70	100	
3	Minor 5	BSCY-503	Polymer Chemistry	3	0	0	3	5	10	15	70	100	
4	Minor 6	BSCY-504	Introduction to Green Chemistry	3	0	0	3	5	10	15	70	100	
5	Internship	BSCY-505I		2	0	0	4	5	10	15	70	100	
6	Practical 5 (based on Major (8+9)	BSCY-506P	Practical - V	0	0	4	2	5	10	15	70	100	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

TOTAL CREDITS / ASSESSMENT							20	30	60	90	420	600	
Department of Chemistry													
B.Sc. Chemistry													
Batch:2025 -26							**SEM:VI**						
S. No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**		
1	Major 10 (Theory)	BSCY-601	Organometallic and Bioinorganic Chemistry	4	0	0	4	5	10	15	70	100	
2	Major 11 (Theory)	BSCY-602	Electrochemistry	4	0	0	4	5	10	15	70	100	
3	Major 12 (Theory)	BSCY-603	Polymer and Materials Chemistry	4	0	0	4	5	10	15	70	100	
4	Minor 7	BSCY-604	Applications of Computers in Chemistry	3	0	0	3	5	10	15	70	100	
5	Minor 8	BSCY-605	Quality Assurance and Control	3	0	0	3	5	10	15	70	100	
6	Practicals - VI (based on Major (11+12)	BSCY-606P	Practicals - VI	0	0	4	2	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Degree	**Year**: Third	**Semester**: Fifth
Subject: CHEMISTRY		
Course Code: BSCY-501	**Course Title**: Analytical Chemistry	

Course Objectives:

After completion of the course, the learner can be able to understand:

1. To expose the students to the basic techniques of Analytical chemistry.
2. To know the application of Instrumentation techniques in analyses
3. To understand the applications of statistics in data analysis.

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. Decide appropriate methods for different analytical needs.
2. Present data in meaningful form. 3. Interpret instrumental results to a communicative form.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials-Practical (in hours per week) : **L-T-P:** 4-0-0

Unit	Topics	Total No of Lectures (60)
I	**Qualitative and quantitative aspects of analysis** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	
II	**Statistical methods in chemical analysis**: Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the Ftest, Q-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

III	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non - aqueous media. **Chromatography:** Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC. Mechanism of separation: adsorption, partition & ion exchange. Development of **chromatograms:** frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.	
IV	**Polarography:** Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.	
V	**Thermal analysis:** Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC).	

SUGGESTED READINGS:

1. Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
2. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA. 16 (1977).
3. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
4. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
5. Ditts, R.V. Analytical Chemistry, Methods of separation, van Nostrand, 1974.
6. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
7. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
8. Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998
9. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
10. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood John Wiley 1979.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
13. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
14. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
15. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.
16. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing California, USA, 1988.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Degree	**Year**: Third	**Semester**: Fifth
Subject: CHEMISTRY		
Course Code: BSCY-502	**Course Title**: Phase equilibria, Chemical Kinetics & surface Chemistry	

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Phases, components, Gibbs phase rule, Phase diagrams and applications.
2. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
3. Catalyst – mechanism, acid base catalysis, enzyme catalysis.
4. Phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
5. The basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
6. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Application of course objectives stated above.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Phase Equilibria:** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems, Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solidvapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water- chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its	

	thermodynamic derivation and applications.	
II	**Chemical Kinetics**: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).	
III	**Surface chemistry:** Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (Excluding derivation), Adsorption in solution. Colloids: Classification, preparation, properties and stability of colloids.	
IV	**Catalysis:** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces, effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis- Menten mechanism, acid base catalysis.	

SUGGESTED READINGS:

1. Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014.
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004.
3. Engel, T. and Reid, P. Physical Chemistry 3rd Ed., Prentice Hall, 2012.
4. McQuarrie, D. A. and Simon, J. D. Molecular Thermodynamics Viva Books, 2004.
5. Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001
6. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press, 2011.
7. Metz, C.R. 2000 Solved Problems in Chemistry, Schaum Series, 2006.
8. Zundhal, S.S. Chemistry concepts and applications Cengage India, 2011 6 Ball, D. W. Physical Chemistry Cengage India, 2012.
9. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP, 2009.
10. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill, 2011.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

-Attendance & Conduct: -Total	05 Marks 30 Marks

Subject Code: BSCY-506P	Practical - V	**2 Credits**

I Polymer Synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA).
2. Preparation of nylon 6,6
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

II Polymer characterization

1. Determination of molecular weight of polyvinyl propylidene in water by viscometry:
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis of polymethacrylic acid.

III Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. IR studies of polymers
3. DSC (Differential Scanning Calorimetry) analysis of polymers
4. TG-DTA (Thermo-Gravimetery-Differential Thermal Analaysis) of polymers.

IV Synthesis of nanomaterials

(a) Synthesis of Metal Nanoparticles
(b) Synthesis of Metal Oxide Nanoparticles
(c) Synthesis of Magnetic Nanomaterials

SUGGESTED READINGS:

1. Fried, J.R. Polymer Science and Technology, Prentice-Hall.. 2003
2. Munk, P.; Aminabhavi, T. M.; Introduction to Macromolecular Science, John Wiley & Sons. 2002
3. Sperling, L.H.; Introduction to Physical Polymer Science, John Wiley 2005 & Sons
4. Allcock, H.R.;Lampe, F. W.; Mark, J. E,Contemporary Polymer Chemistry, Prentice Hall. 20

Components for Continuous Internal Assessment (CIA) for practical course: -One Mid Semester Written Test (1x15): inar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

Programme / Class: Undergraduate Degree	**Year**: Third	**Semester**: Sixth
Subject: CHEMISTRY		
Course Code: BSCY-601	**Course Title**: Organometallic and Bioinorganic Chemistry	

Course Objectives:

After completion of the course, the learner can be able to understand: Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.

1. Transition metals, its stability, colour, oxidation states and complexes.
2. Lanthanides, Actinides – separation, colour, spectra and magnetic behavior
3. Bioinorganic chemistry – metal ions in biological system, its toxicity, haemoglobin.
4. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
5. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
6. Understanding the separation of Lanthanides and Actinides, its colour, spectra and magnetic behaviour.
7. Understanding the bioinorganic chemistry of metals in biological systems.
8. Haemoglobin and its importance in biological systems.

Course Learning Outcomes:

1. Application of course objectives stated above.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Organometallic Compounds**: Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

	carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series.	
II	**Synergic effects:** EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures, properties and reactions of organometallic compounds of Mg, Al,Sn and Li – Use in synthesis of organic compounds.	
III	**Ferrocene & Zeise's salt:** Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. Preparation & structure of Zeise's salt. Evidences of synergic effect and comparison of synergic effect with that in carbonyls.	
IV	**Metal Alkyls:** Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.	
V	**Bioinorganic chemistry:** A brief introduction to bio-inorganic chemistry. Geochemical effect on distribution of metals. Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions: Na/K pump, Role of Mg^{2+} ions in energy production and chlorophyll. Iron and its application in bio- systems, Haemoglobin, Myoglobin, Storage and transfer of iron. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	
VI	**Catalysis by Organometallic Compounds :** Study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinsons Catalyst) 2. Hydroformylation (Co salts) 3. Wacker Process 4. Synthetic gasoline (Fischer Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes.	

SUGGESTED READINGS:

1. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
2. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
4. Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: Third	**Semester**: Sixth
Subject: CHEMISTRY		
Course Code: BSCY-602	**Course Title**: Electrochemistry	

Course Objectives:

After completion of the course, the learner can be able to understand:

1. Basic principle of electrochemistry, chemical cells and their function, EMF measurement, potentiometric titrations and their applications.

Course Learning Outcomes:

1. Application of course objectives stated above.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Conductance:** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities,	

	mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) hydrolysis constants of salts etc.	
II	**Electrochemistry**: Quantitative aspects of Faraday's law. Applications of electrolysis in metallurgy and industry. Half-cell potential, Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation, Standard electrode (reduction) potential and its application of different kind of half-cells. Electrified interfaces, overpotential, Electrocatalysis- influence of various parameters. Hydrogen electrode.	
III	**Application of EMF measurements:** Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential, determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	
IV	**Electroanalytical methods** Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.	
V	**Electrical & Magnetic Properties of Atoms and Molecules:** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.	
VI	**Principles of Corrosion:** Introduction to corrosion, homogenous theory, electrolytic theory of corrosion, forms of corrosion, special attention to rusting and its influence of economy of the world, corrosion monitoring and prevention methods.	

SUGGESTED READINGS:

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: Third	**Semester**: Sixth
Subject: CHEMISTRY		
Course Code: BSCY-603	**Course Title**: Polymer and Material Chemistry	

Course Objectives:

After completion of the course, the learner can be able to understand:

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis.
4. Characterization of polymers

Course Learning Outcomes:

On successful completion of this course the student should be able to understand:

1. Student will explore various aspects of Polymerisation.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 =100	**Min. Passing Marks: 40**

Total No. of Lectures - Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0

Unit	**Topics**	**Total No.**

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

		of Lectures (60)
I	**Introduction:** Introduction and classification of Polymers, Biopolymers, Synthetics polymers. polymerization process, degree of polymerization, condensation and addition polymers, kinetics of addition polymerization process.	
II	**Polymeric Structure and Property Relationship:** Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average and weight average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, van der Waals volume, Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.	
III	**Characterization of Polymers:** Molecular Weight Determination by Light scattering, End-group analysis, Viscosity, Applications of FTIR, UV-visible, NMR and Mass Spectroscopy for identification of polymers.	
IV	**Properties of Polymers**: Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol-formaldehyde resins, polyurethanes, silicone polymers, polydienes, Polycarbonates.	
V	**Material Chemistry** Material Chemistry often covers a broader range of solid-state and advanced materials. Specific topics can vary, but generally include: Solid State Structure: Types of solids (crystalline, amorphous). Crystalline materials: space lattice, unit cell, crystal planes, Miller indices. Laws of crystallography (constancy of interfacial angles, rationality of indices, symmetry). Symmetry elements in crystals. X-ray diffraction by crystals, Bragg's equation., Crystal defects (point, line, surface defects).	
VI	**Properties of Materials:** Electrical properties: Conductors, semiconductors (intrinsic, extrinsic, n-type, p-type), insulators, superconductors (basic concepts). Magnetic properties: Diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism. Optical properties: Luminescence, phosphorescence, fluorescence, lasers (basic principles).Thermal properties:	

	Heat capacity, thermal conductivity, thermal expansion.	
VII	**Advanced Materials:** Ceramics: Types, properties, applications. Composites: Definition, types (fiber-reinforced, particulate, laminar), properties, applications. Nanomaterials: Introduction to nanotechnology, synthesis methods (top-down, bottom-up), properties of nanomaterials (quantum dots, nanotubes, nanowires), applications. Liquid Crystals: Classification, properties, applications. Biomaterials: Introduction, types, applications in medicine. Smart Materials: Shape memory alloys, pH-sensitive materials, self-healing materials (brief introduction).	

SUGGESTED READINGS:

1. D.W. Van Krevelen and P.J. Hoftyzen, Properties of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties of Polymers Hand Book, Williston, Vt, 1996.
3. S K Gupta and Anil Kumar, Reaction Engineering of Step Growth Polymerization, Plenum Press, 1987
4. Odian, George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
7. Billmeyer Jr., Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).
8. R. S. Drago, 1992, Physical methods for chemistry: Saunders college publication.
9. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
10. P. Ghosh, Polymer Science and technology, Plastics, Rubber and composites, Tata McGraw Hill.
11. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int. Publication, 2019.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Subject Code: BSCY-606P	Practical - VI	**2 Credits**

I Polymer Synthesis

1.Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA).
2. Preparation of nylon 6,6
3. Redox polymerization of acrylamide

4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

II Polymer characterization

1. Determination of molecular weight of polyvinyl propylidene in water by viscometry:
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis of polymethacrylic acid.

III Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. IR studies of polymers
3. DSC (Differential Scanning Calorimetry) analysis of polymers
4. TG-DTA (Thermo-Gravimetery-Differential Thermal Analysis) of polymers.

II Synthesis of nanomaterials

(a) Synthesis of Metal Nanoparticles
(b) Synthesis of Metal Oxide Nanoparticle
(c) Synthesis of Magnetic Nanomaterials

SUGGESTED READINGS:

1. Fried, J.R. Polymer Science and Technology, Prentice-Hall.. 2003
2. Munk, P.; Aminabhavi, T. M.; Introduction to Macromolecular Science, John Wiley & Sons. 2002
3. Sperling, L.H.; Introduction to Physical Polymer Science, John Wiley 2005 & Sons
4. Allcock, H.R.;Lampe, F. W.; Mark, J. E,Contemporary Polymer Chemistry, Prentice Hall. 20

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Department of Chemistry														
Course B.Sc. Chemistry														
Batch:2025 -26								**SEM:VII**						
S.No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**	
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**			
1	Major 13 (Theory)	BSCY-701	Reaction Mechanisms and Electronic Spectra in Inorganic Chemistry	5	0	0	5	5	10	15	70	100		
2	Major 14 (Theory)	BSCY-702	Molecular Spectroscopy and Photochemistry	3	0	0	3	5	10	15	70	100		
3	Major 15 (Theory)	BSCY-703	Heterocyclics and Biomolecules	4	0	0	4	5	10	15	70	100		
4	Minor 9	BSCY-704	Research Methodology	4	0	0	4	5	10	15	70	100		
5	Practical - VII (based on Major (14	BSCY-705P	Practicals - VII	0	0	4	2	5	10	15	70	100		
6	Practicals- VIII (based on Major 15)	BSCY-706P	Practicals-VIII	0	0	4	2	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**		

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Department of Chemistry

Course B.Sc. Chemistry

Batch:2025-26							SEM:VIII						
S.No.	Course Type	Course Code	Course	Teaching Load			CREDITS	Internal Assessment			External Assessment	Total	Remark
	THEORY and PRACTICAL SUBJECTS			L	T	P		Attendance (5)	Quiz/PPT/ Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 16 (Theory)	BSCY-801	Quantum and Nanochemistry	4	0	0	4	5	10	15	70	100	
2	Minor 10	BSCY-802	Research Publications and Ethics	4	0	0	4	5	10	15	70	100	
4	Research Project / Dissertation	BSCY-803R		0	0	0	12	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							**20**	**120**			**280**	**300**	

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Programme / Class: Undergraduate Degree (Hons with Research)	**Year**: Fourth	**Semester**: Seventh
Subject: CHEMISTRY		
Course Code: BSCY-701	**Course Title**: Reaction Mechanisms and Electronic Spectra in Inorganic Chemistry	

Course Objectives:

On completion of this course, the students will be able to understand

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules

Credits: 5	**Core:** Compulsory
Max.Marks:30+70=100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 5-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Reaction Mechanism of Transition Metal Complexes :** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer- sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.	
II	**Metal-Ligand Bonding in complexes:** Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.	

III	**Electronic Spectra and Magnetic Properties of Transition Metal Complexes:** Spectroscopic ground states, Term symbol, Selection rule, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1 - d9 states), calculations of dq and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.	
IV	**Metal Clusters:** Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.	
V	**Metal π-Complexes:** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes: tertiary phosphine as ligand.	

SUGGESTED READINGS:

1. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, John Wiley.
2. J.E. Huhey, Harpes & Row; Inorganic Chemistry.
3. N.N. Greenwood and A. Earnshow, Chemisiry of the Elements, Pergamon.
4. A. B. P. Leve r, Inorganic Electron ion Spectroscopy, Elsevier.
5. R.L. Cariin, Magnetochemistry, Springer Vertag,
6. Q. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, Comprehensive Coordination Chemistry eds., Pergamon

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree (Hons with Research)	**Year**: Fourth	**Semester**: Seventh

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Subject: CHEMISTRY	
Course Code: BSCY-702	**Course Title**: Molecular Spectroscopy and Photochemistry

Course Objectives:

This course is designed:

To expose the students to the basic principles of spectroscopic theory. Application of spectroscopic techniques in organic chemistry. Interaction of electromagnetic radiations and matter. Applications of spectroscopic analysis to elucidate structure of organic compounds.

Course Learning Outcomes:

On successful completion of this course the student should be able to understand:

1. Correlate theory and experimental findings in order to explore structural features of organic compounds.
2. Apply the concept to establish structures of unknown compounds.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70=100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P: 3**-0-0

Unit	**Topics**	**Total No. of Lectures (60)**
I	**Organic Spectroscopy:** General principles: Introduction to absorption and emission spectroscopy. Interaction of electromagnetic radiation with molecules & various types of spectra and Born- Oppenheimer approximation.	
II	**UV Spectroscopy:** Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption, Application of Woodward - Fieser rules for calculation of λmax for the following systems: α, β-unsaturated aldehydes, ketones, carboxylic acids and esters, Conjugated dienes: alicyclic, homoannular and heteroannular and extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.	
III	**IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations, Infrared radiation and types of molecular vibrations. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). Effect of H-bonding, conjugation, resonance and ring size on IR absorptions, Fingerprint region and its significance, application in functional group analysis.	

IV	**NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it, Spin–Spin coupling and coupling constant, Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.	
V	**Mass Spectroscopy:** Basics of fragmentations in organic compounds. Discussion of molecular ion peak, base peak and metastable ions, McLafferty rearrangement. Nitrogen rule, Index of hydrogen deficiency. Application of fragmentation in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data. Applications of IR, UV, NMR and Mass spectra for identification of simple organic molecules.	
VI	**Electronic Spectroscopy:** Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and pre-dissociation.	
VII	**Atomic spectroscopy:** Atomic absorption spectroscopy, theory and application (with some example).	
VIII	**Photophysical and photochemical processes**: Laws of photochemistry, quantum yield. Jablonski diagrams: Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($H_2 + Br_2 \rightarrow 2HBr$, $H_2 + Cl_2 \rightarrow 2HCl$, $2HI \rightarrow H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).	

SUGGESTED READINGS:

1. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999
2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998
4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).
5. Banwell C.N. & Mc Cash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
6. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
7. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

Components for Continuous Internal Assessment (CIA) for theory course:	

-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

Subject Code: BSCY-705P	Practical - VII	**2 Credits**

I Spectrophotometry

1. To verify Beer – Lambert Law for KMnO4/K2Cr2O7 and determining the concentration of the given solution of the substance from absorption measurement
2. Determination of pKa values of indicator using spectrophotometry.
3. Determination of chemical oxygen demand (COD)
4. Determination of Biological oxygen demand (BOD).

II Spectroscopy

1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided).
2. Assignment of labelled peaks in the 1H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern.
3. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided). 10

III Chromatographic Separations

1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II)
2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC)
3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values
4. TLC separation of a mixture of dyes (fluorescein and methylene blue).

SUGGESTED READINGS:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6 th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

7. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic & AlliedMethods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree (Hons with Research)	**Year**: Fourth	**Semester**: Seventh
Subject: CHEMISTRY		
Course Code: BSCY-703	**Course Title**: Heterocyclics and Biomolecules	

Course Objectives:
After completion of the course, the learner shall be able to understand:
Understanding reactions and reaction mechanism of compounds containing active methylene groups. Understanding the reactions and mechanisms of diazonium compounds. Understanding the structure, mechanism of reactions of selected heterocyclic compounds. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

Course Learning Outcomes:
On successful completion of this course the student should know: Elucidating reaction mechanisms for organic reactions. Use of active methylene groups in organic mechanism and preparation of new organic compounds. Use of benzene diazonium salt in organic synthesis. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.

Credits: 4	**Core:** Compulsory
Max. Marks: 30 + 70 = 100	**Min. Passing Marks: 40**
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0	

Unit	Topics	Total No. of Lectures (60)
I	**Heterocyclic Compounds:** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom, Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and Furoic acid.	
II	**Chemistry of Carbohydrates**: Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures, Interconversions of aldoses and ketoses, Killiani- Fischer synthesis and Ruff degradation, Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen excluding their structure elucidation.	
III	**Chemistry of Enzymes and correlation with drug action :** Mechanism and factors affecting of enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecifity). Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non- competitive inhibition including allosteric inhibition).	
	Chemistry of Lipids Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).	
	Chemistry of Dyes: Classification, Colour and chemical constitution, Mordant and Vat Dyes, Chemistry of dyeing, Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling), Triphenylmethane dyes -Malachite Green, Rosaniline and Crystal Violet, Phthalein dyes – Phenolphthalein and Fluorescein, Natural dyes –structure elucidation and synthesis of Alizarin and Indigo, Edible Dyes with examples.	

SUGGESTED READINGS:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
3. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).

4. Solomons, T.W., Fryhle Craig, Organic Chemistry, John Wiley & Sons, Inc (2009).
5. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
6. Kalsi, P. S. Organic reacations and their mechanisms, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., Organic Chemistry, Oxford University Press Inc., New York (2001).
8. Singh, J., Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).
9. Bansal R. K. Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms, New Age, Third Edition (1999).
10. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry, Cengage Lening India Pvt. Ltd., New Delhi (2009).
11. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
12. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
13. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
14. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
15. Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.
16. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
17. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
18. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
19. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7 th Ed., W. H. Freeman.
20. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7 th Ed., W. H. Freeman.

Components for Continuous Internal Assessment (CIA) for theory course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Subject Code: BSCY-706P	Practical - VIII	**2 Credits**
I. Biomolecules:		

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1. Saponification value of an oil or a fat.

2. Determination of Iodine number of an oil/ fat.

3. Extraction of caffeine from tea leaves.

4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.

5. Qualitative analysis of unknown organic compounds containing monofunctional groups.

II. Estimations

a. Estimation of amino group by brominating method.

b. Estimation of Phenolic group by brominating method.

c. Estimation of glucose by Fehling solution method.

d. Estimation of glucose by Bendicts solution method.

e. Estimation of amino acid. f. Estimation of Formaldehyde.

III. Separation and identification

a. Separation and identification of organic compounds from the following mixture.

i. Benzoic acid + β – napthol.

ii. ρ – toludine + naphthalene.

IV. Green Synthesis:

(a). Diels Alder reaction in water

(b). Reaction between furan and maleic acid in water at room temperature rather than in benzene which requires refluxing.

SUGGESTED READINGS:

1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; American Chemical Society, Washington DC (2002). 4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7

(2013).
5. Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
7. Pavia, D. L. Lamponan, G. H. &Kriz, G.S. W B Introduction to organic laboratory.
8. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
9. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.

Components for Continuous Internal Assessment (CIA) for practical course:	15 Marks
-One Mid Semester Written Test (1x15):	10 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	05 Marks
-Attendance & Conduct:	30 Marks
-Total	

Programme / Class: Undergraduate Degree (Hons with Research)	**Year**: Fourth	**Semester**: Eighth
Subject: CHEMISTRY		
Course Code: BSCY-801	**Course Title**: Quantum and Nanochemistry	

Course Objectives:
After completion of the course, the learner can be able to understand:
1. Basic principle of laws of electrochemistry.
2. Understanding about chemical cells and their function
3. Understanding about electrodes, EMF measurement.
4. Understanding about potentiometric titrations and their applications.

Course Learning Outcomes:
Application of course objectives stated above.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Introduction to Quantum Chemistry:** Introduction to black-body radiation and distribution of energy, photo-electric	

	effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), Plank's Quantum theory. The uncertainty principle, the wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and eigen values.	
II	**The Schrodinger wave equation:** Postulates of quantum mechanics, the Schrodinger wave equation. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in one dimensional box, three-dimensional box, the harmonic oscillator, the rigid rotor and the hydrogen atom. Schrodinger equation in spherical polar coordinates and separation of R(r), Θ(ө) & Φ(ф) (radial and angular parts), degeneracies, spherical harmonics of the hydrogen atoms.	
III	**Approximate Methods for multi electron system:** The variation method, Perturbation theory (first order and non-degenerate) and the W.K.B. method. Applications of variation method and perturbation theory to the Helium atom.	
IV	**Angular momentum :** Ordinary angular momentum, generalized angular momentum (quantum mechanical approach), communication relation, eigen functions for angular momentum, eigen values of angular momentum. Operators: Ladder operators, raising and lowering operator, addition of angular momenta, spin, antisymmetric and Pauli exclusion principle.	
V	**Electronic Structure of Atoms** :Electronic configuration, Russell- Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the pn configuration, term separation energies for the dn configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self -consistent field, the virial theorem.	
VI	**Chemical bonding:** Valence bond and Molecular orbital approaches, LCAO-MO treatment of H2, H2 + , bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of H2 (only wave functions, detailed solution not required) and their limitations. Average and most probable distances of electron from nucleus.	
VII	**Molecular Orbital Theory**: Huckel theory of conjugated systems, bond order and charge density calculations. Applications	
VIII	**Introduction to nanoscience, nanostructure and nanotechnology:** Basic idea; Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures, Spheroid, Wire, Rod, Tube, and Quantum Dot. Carbon nanotubes and inorganic nanowires. Calculation of	

	percentage of surface atom and surface to volume ratio of spherical, wire, rod and disc shapes nanoparticles.	
IX	**Size dependent properties of nanomaterials:** Basic idea with few examples only: Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colours (Blue shift & Red shift), Magnetic, thermal and catalytic properties.	
X	**Synthesis of Nanomaterials:** Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, selfassembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.	

SUGGESTED READINGS:

1. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
2. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
3. Zhen Guo and Li Tan, Fundamentals and Applications of Nanomaterials.2009, Artech House, London Publication.
4. C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004
6. R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
7. Charles P. Poole and Frank J Owens, Introduction to nano technology, Wiley, interscience, 2003.
8. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

MINOR SYLLABUS

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: I
Subject: CHEMISTRY		
Course Code: BSCY-102	**Course Title**: Nuclear and Environmental Chemistry	

Course Objectives:

1. To understand nuclear chemistry fundamentals
2. To explain radioactive processes
3. To measure and analyze radioactivity
4. To understand nuclear reactions and applications
5. To apply nuclear chemistry in real-world contexts
6. To analyze environmental chemistry concepts
7. To understand pollution control techniques
8. To evaluate sustainability and safety

Course Learning Outcomes

After completing this course, students will be able to:

- Describe nuclear structure
- Predict nuclear stability and decay patterns
- Measure and interpret radioactivity data
- Explain nuclear reactions
- Apply nuclear chemistry in practical contexts
- Understand water pollution and treatment methods
- Evaluate the impact of nuclear and chemical hazards

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0

Unit	Topics	Total No. of Lectures
I	**Nuclear Chemistry** The nucleus: subatomic particles, liquid drop model; forces in nucleus-mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements. Radioactive decay- α-decay, β-decay, γ-decay; neutron emission, positron emission; unit of radioactivity (curie); half - life period; radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger Counters, Scintillation counters. Nuclear reactions: Nuclear fission-theory of nuclear fission; chain reaction; nuclear fusion; nuclear reactors-fast breeder reactors,	

	fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear reactors in India. Applications: Dating of rocks and minerals, carbon dating, neutron activation analysis, isotopic labeling studies, nuclear medicine- 99mTc radio pharmaceuticals. Nuclear disasters – Chernobyl disaster, Three Mile Island Disaster, Disposal of nuclear waste and its management	
II	**Air Pollution** Major regions of atmosphere, chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature, Major sources of air pollution, Pollution by SO2, CO2, CO, NOx, H2S and other foul-smelling gases, methods of estimation of CO, NOx, SOx and control procedures. Chemistry and environment impact of the following: Photochemical smog, Greenhouse effect, Ozone depletion Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs	
III	**Water Pollution:** Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for wastewater, industrial water and domestic water.	

SUGGESTED READINGS:

1. Skoog, D. A., Holler, F. J., and Crouch, S. R. Principles of Instrumental Analysis. Cengage Learning, Boston, 2018.
2. Friedlander, G., Kennedy, J. W., Macias, E. S., and Miller, J. M. Nuclear and Radiochemistry. Wiley, New York, 1981.
3. Choppin, M. G., Rydberg, J., Liljenzin, J. O., and Ekberg, C. Radiochemistry and Nuclear Chemistry. Butterworth-Heinemann, Oxford, 2013.
4. Metcalf & Eddy, Inc. Wastewater Engineering: Treatment and Resource Recovery. McGraw-Hill Education, New York, 2014.
5. American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). Standard Methods for the Examination of Water and Wastewater. APHA Press, Washington D.C., 2017.
6. Girard, J. E. Principles of Environmental Chemistry. Jones & Bartlett Learning, Burlington, MA, 2014.
7. Baird, C., and Cann, M. Environmental Chemistry. W. H. Freeman and Company, New York, 2012.

Components for Continuous Internal Assessment (CIA) for practical course:	

-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: II
Subject: CHEMISTRY		
Course Code: BSCY-202	**Course Title**: **Inorganic Materials of Industrial Importance**	

Course Objectives:

Understand the chemistry of silicate materials
Learn fertilizer chemistry
Examine surface coatings
Introduce nanomaterials
Develop industrial application skills
Promote awareness of eco-friendly materials

Course Learning Outcomes:

After completing this course, students will be able to:

Describe silicate materials
Explain cement chemistry
Understand fertilizer chemistry
Analyze surface coatings
Explain metallic and contemporary coatings
Characterize nanomaterials

Integrate theory with applications

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Promote sustainable practices		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	**Topics**	**Total No. of Lectures**
I	**Silicate Industries** Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, coloured glass, photosensitive glass, photochromic glass, glass wool and optical fibre. Cement: Manufacture of Portland cement and the setting process, Different types of cements: quick setting cements, eco-friendly cement (slag cement), pozzolana cement.	
II	**Fertilizers** Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime and potassium nitrate.	
III	**Surface Coatings** Brief introduction to and classification of surface coatings, paints and pigments: formulation, composition and related properties, pigment volume concentration (PVC)and critical pigment volume concentration (CPVC), fillers, thinners, enamels and emulsifying agents. Special paints: heat retardant, fire retardant, eco-friendly paints, plastic paints, water and oil paints. Preliminary methods for surface preparation, metallic coatings (electrolytic and electroless with reference to chrome plating and nickel plating), metal spraying and anodizing. Contemporary surface coating methods like physical vapor deposition, chemical vapor deposition, galvanising, carburizing, sherardising, boriding, nitriding and cementation.	

IV	Brief introduction to and classification of surface coatings, paints and pigments: formulation, composition and related properties, pigment volume concentration (PVC)and critical pigment volume concentration (CPVC), fillers, thinners, enamels and emulsifying agents. Special paints: heat retardant, fire retardant, eco-friendly paints, plastic paints, water and oil paints. Preliminary methods for surface preparation, metallic coatings (electrolytic and electroless with reference to chrome plating and nickel plating), metal spraying and anodizing. Contemporary surface coating methods like physical vapor deposition, chemical vapor deposition, galvanising, carburizing, sherardising, boriding, nitriding and cementation.	
V	**Nano dimensional materials** Introduction to zero, one and two-dimensional nanomaterial: Synthesis, properties and applications of fullerenes, carbon nanotubes, carbon fibres, semiconducting and superconducting oxides.	

SUGGESTED READINGS:

1. Harnung, Sven E. & Johnson, Matthew S. Chemistry and the Environment. Cambridge University Press, 2012.
2. Moore, J.W. & Moore, F.A. Environmental Chemistry, Academic Press (New Delhi / International editions).
3. Manahan, Stanley E. Environmental Chemistry, 9th (or later) ed., CRC Press.
4. Lichtfouse, Eric; Schwarzbauer, Jan; Robert, Didier (Eds). Environmental Chemistry: Green Chemistry and Pollutants in Ecosystems. Springer, 2005

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
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NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Diploma	**Year**: 2	**Semester**: III
Subject: CHEMISTRY		
Course Code: BSCY-303	**Course Title** : Industrial Chemicals and Environment	

Course Objectives:
The objectives of this course are to:

Introduce industrial gases and inorganic chemicals.
Promote safety awareness
Explain environmental segments and ecosystems
Understand sources and effects of air pollution
Analyze water pollution and treatment.
Discuss energy sources and environmental impact
Promote sustainable and eco-friendly practices

Course Learning Outcomes

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

Identify and classify industrial gases
Explain inorganic chemical hazards and handling
Understand ecological concepts
Analyze air pollutants and their reactions
Evaluate environmental problems
Determine water quality parameters
Understand wastewater and effluent treatment
Discuss energy resources and sustainability
Apply safety and environmental ethics
Integrate environmental chemistry with industrial applications

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0

Unit	Topics	Total No. of Lectures
I	**Industrial Gases and Inorganic Chemicals** **Industrial Gases:** Hazards and safety measures in Large scale production (excluding manufacturing process), uses, storage of the following gases:	

	oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic Chemicals: Hazards and safety measures(excluding manufacturing process.) in the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thio-sulphate, hydrogen peroxide, potash alum, potassium dichromate and potassium permanganate.	
II	**Environment and its segments** Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulfur. Air Pollution: Chemical and photochemical reactions in the atmosphere. Air pollutants: types, sources, particle size and chemical nature; Dust, Smoke and particulates, smog and its constituents. Environmental effects of ozone. Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens. ***Water Pollution:*** Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary and secondary treatment). Industrial waste management, Water quality parameters for waste water, industrial water and domestic water.	
III	**Energy & Environment** Sources of Energy: Coal, petrol and natural gas. Nuclear Fusion/Fission, Solar energy, Hydrogen, etc. *Nuclear Pollution:* Disposal of nuclear waste, nuclear disaster and its management.	

SUGGESTED READINGS:

1. Van Loon, G. W., and Duffy, S. J. Environmental Chemistry: A Global Perspective. Oxford University Press, Oxford, 2017.
2. Harnung, S. E., and Johnson, M. S. Chemistry and the Environment. Cambridge University Press, Cambridge, 2012.
3. Dara, S. S., and Mishra, A. Textbook of Engineering Chemistry. S. Chand & Company Ltd., New Delhi, 2014.
4. Jain, P. C., and Jain, M. Engineering Chemistry. Dhanpat Rai Publishing Company, New Delhi, 2015.
5. Cheremisinoff, N. P. Handbook of Air Pollution and Control Technologies. Marcel Dekker Inc., New

York, 2002.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Diploma	**Year**: 2	**Semester**: IV
Subject: CHEMISTRY		
Course Code: BSCY-404	**Course Title** Applied Organic Chemistry	

Course Objectives:

The objectives of this course are to:

1. Establish foundational understanding of structure, bonding, and reactivity relationships in organic compounds.
2. Develop mechanistic insight into organic reactions, reactive intermediates, and strategies for organic synthesis.
3. Introduce heterocyclic, bio-organic, and functional materials and explore their synthesis, reactivity, and applications.
4. Connect laboratory organic chemistry with industrial applications through study of scale-up processes, catalysis, and sustainable chemical manufacturing.
5. Train students in spectroscopic methods (IR, NMR, Mass, UV-Vis) for structural elucidation and characterization of organic compounds.
6. Promote awareness of green chemistry principles and sustainable practices in organic synthesis and industrial processes.

Course Learning Outcomes

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

- Explain structure–reactivity relationships by applying concepts of bonding, hybridisation, resonance, inductive and mesomeric effects, and hyperconjugation.
- Interpret molecular parameters such as bond length, bond angle, bond energy, and dipole moment in relation to reactivity and stability.
- Classify and predict reaction types including substitution, addition, elimination, and rearrangement mechanisms.
- Identify and describe reactive intermediates such as carbocations, carbanions, radicals, and carbenes and evaluate their role in reaction mechanisms.
- Differentiate kinetic and thermodynamic control in organic reactions and apply isotopic labeling and mechanistic tools to elucidate reaction pathways.
- Describe heterocyclic compounds
- Discuss bio-organic and polymer chemistry
- Relate laboratory synthesis to industrial processes
- Evaluate sustainability in organic chemistry
- Analyze and interpret spectroscopic data (IR, NMR, UV-Vis, Mass) to determine structures of organic compounds.

Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		
Unit	**Topics**	**Total No. of Lectures**
I	**Foundations & Structure-Reactivity Relationships** Review of bonding, hybridisation, resonance, inductive/hyperconjugation effects. Molecular parameters: bond lengths, bond angles, bond energies, dipole moments. Isomerism, stereochemistry: optical activity, E/Z, R/S, pro-chirality, conformations. .	
II	**Reaction Mechanisms & Synthetic Strategy** Classification of organic reactions (substitution, elimination, addition, rearrangement). Reactive intermediates: carbocations, carbanions, radicals, carbenes. Kinetic vs thermodynamic control; isotopic labelling; mechanistic tools. Named reactions (e.g., Aldol, Claisen, Dieckmann, etc.).	
III	**Heterocycles, Functional Materials & Bio-organic Applications** Chemistry of heterocyclic compounds: classification, synthesis, reactions. Polymers and industrial materials derived from organic compounds. Natural products: extraction, structure, applications (e.g., alkaloids, terpenes)	
IV	**Industrial and Applied Processes** Scale-up: from lab synthesis to industrial processes - material balance, catalyst role, reaction engineering. Petrochemical derivatives and major organic industrial chemicals. Sustainability issues in organic synthesis: green chemistry, waste minimisation, energy/mass optimisation. Case-studies of industrial syntheses of key organic compounds.	
V	**Spectroscopy & Structure Elucidation in Applied Contexts** Use of IR, NMR, Mass spec, UV-Vis in organic compound characterisation. Application of spectroscopic techniques in industry and research settings	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

SUGGESTED READINGS:

1.Carey, F.A. & Sundberg, R.J., Advanced Organic Chemistry: Part A: Structure and Mechanisms (and Part B: Reactions and Synthesis).
2.Clayden, J., Greeves, N., Warren, S., Organic Chemistry.
3.Kalsi, P.S., Stereochemistry: Conformation and Mechanism.
4.Gilchrist, T.L., Heterocyclic Chemistry.
5.Norman, R.O.C. & Coxon, J.M., Principles of Organic Synthesis.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: 3	**Semester**: V
Subject: CHEMISTRY		
Course Code: BSCY-503	**Course Title Polymers Chemistry**	

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamentals of polymer chemistry
2. Explain the principles of polymerization
3. Correlate polymer structure with properties
4. Develop understanding of polymer characterization.
5. Study the preparation and applications of important polymers
6. Explore frontier areas in polymer science
7. Understand fibers and rubbers
8. Promote awareness of sustainable polymer materials

Course Learning Outcomes

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

- Classify polymers
- Explain polymerization mechanisms
- Define molecular parameters

- Discuss polymer architecture
- Correlate structure with thermal behavior .
- Explain volumetric and mechanical properties
- Apply polymer characterization techniques
- Identify major industrial polymer

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P: 3**-0-0

Unit	Topics	Total No. of Lectures
I	**Introduction:** Introduction and classification of Polymers, Biopolymers, Synthetics polymers. polymerization process, degree of polymerization, condensation and addition polymers, kinetics of addition polymerization process.	
II	**Polymeric Structure and Property Relationship:** Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average and weight average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, van der Waals volume, Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship. Characterization of Polymers: Molecular Weight Determination by Light scattering, End-group analysis.	
III	**Properties of Polymers:** Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol-formaldehyde resins, polyurethanes, silicone polymers, polydienes, Polycarbonates.	
IV	**Frontier areas of polymer science and technology:** Conducting polymers: Basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers. Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soya protein, corn, zein protein, wheat gluten protein,	

	synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, polyvinyl alcohol, polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells. Fibers: Natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA. Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.	

SUGGESTED READINGS:

1. Billmeyer, F. W. Textbook of Polymer Science. 3rd ed., John Wiley & Sons, New York, 1984.
2. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. Polymer Science. New Age International Publishers, New Delhi, 2017.
3. Rodriguez, F. Principles of Polymer Systems. 5th ed., Taylor & Francis, London, 2003.
4. Sperling, L. H. Introduction to Physical Polymer Science. 4th ed., Wiley-Interscience, Hoboken, NJ, 2006.
5. Young, R. J., & Lovell, P. A. Introduction to Polymers. 3rd ed., CRC Press, Boca Raton, 2009.
6. Fried, J. R. Polymer Science and Technology. 3rd ed., Prentice Hall, New Jersey, 2014.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: 3	**Semester**: V
Subject: CHEMISTRY		
Course Code: BSCY-504	**Course Title: Introduction to Green Chemistry**	

Course Objectives:

The objectives of this course are to:

1. Introduce the concept and need for Green Chemistry
2. Understand and apply the twelve principles of Green Chemistry
3. Develop skills in designing green syntheses
4. Explore green solvents and alternative energy sources
5. Apply catalysis and safer reaction design principles
6. Analyze real-world examples of green chemistry
7. Introduce future trends in sustainable chemistry
8. Promote environmental responsibility and sustainability awareness

Course Learning Outcomes

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

- Define Green Chemistry
- Describe and interpret the twelve principles of Green Chemistry
- Design green synthetic routes
- Identify and compare green solvents
- Apply alternative energy sources
- Evaluate real-world green synthesis examples
- Discuss environmentally safe products
- Explore future innovations
- Integrate sustainability into chemical practice

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0

Unit	Topics	Total No. of Lectures
I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry	
II	**Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy. Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous	

	catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	
III	**Examples of Green Synthesis/ Reactions and some real world cases** 1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) 2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments. 5 Designing of Environmentally safe marine antifoulant. 6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments. 7 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 8 Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils 9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting	
IV	**Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development	

SUGGESTED READINGS:

1. Anastas, P. T., & Warner, J. C. Green Chemistry: Theory and Practice. Oxford University Press, Oxford, 1998.
2. Lancaster, M. Green Chemistry: An Introductory Text. Royal Society of Chemistry, Cambridge, 2010.
3. Clark, J. H., & Macquarrie, D. J. Handbook of Green Chemistry and Technology. Blackwell Science Ltd., Oxford, 2002.
4. Anastas, P. T., & Kirchhoff, M. M. Origins, Current Status, and Future Challenges of Green Chemistry. Accounts of Chemical Research, 2002.
5.Matlack, A. S. Introduction to Green Chemistry. 2nd ed., CRC Press, Boca Raton, 2010.
6. Leitner, W., Schüth, F., Sundermeyer, J., & Hieronymus, H. Handbook of Green Chemistry. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2011.

7. Cheremisinoff, N. P. Handbook of Air Pollution and Control Technologies. Marcel Dekker Inc., New York, 2002.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: 3	**Semester**: VI
Subject: CHEMISTRY		
Course Code: BSCY-604	**Course Title: Applications of Computers in Chemistry**	

Course Objectives:

The objectives of this course are to:

1. Introduce basic computer systems
2. Develop familiarity with programming concepts
3. Provide a foundation in Python programming
4. Teach data types and control structures
5. Introduce numerical methods
6. Promote the use of scientific Python packages
7. Enable practical applications in chemistry
8. Develop computational thinking and problem-solving skills

Course Learning Outcomes

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

- Describe computer architecture and components
- Differentiate number systems and computer codes
- Distinguish programming languages
- Operate basic software tools
- Manipulate complex data structures
- Analyze chemical data statistically
- Solve chemistry-specific computational problems
- Integrate computational and chemical knowledge

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0

Unit	Topics	Total No. of Lectures
I	**Basic Computer system** Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Software languages: Low level and High-Level languages (Machine language, Assembly language; QBASIC, C, C++, FORTRAN 90&95); Compiled versus interpreted languages. Debugging Software Products (Office, chemsketch, scilab, matlab, and hyperchem), internet application	
II	**Introduction to Python** Why Python? Python coding environment setup, Python as an interpreted language, Brief history of Python, Uses of Python (including artificial intelligence and machine learning), Applications of Python in Chemistry	
III	**Coding in Python** (i) Basic syntax including constants and variables, Operators, Data Types, Declaring and using Numeric data types: int, float, string etc. (ii) Program Flow Control Conditional blocks: if, else and else if, simple FOR loops, FOR loop using ranges, string, list and dictionaries. Use of while loops, Loop manipulation using pass, continue, break and else. (iii) Complex data types: String, List, Arrays, Tuples and Dictionary, String operations and manipulation methods, List operations including slicing, in-built Python Functions. (iv) Python packages - usage of numpy and scipy for mathematical computations.	

IV	**Numerical Methods in Chemistry** Solution of quadratic equation, polynomial equations (formula, iteration, Newton – Raphson methods and binary bisection) with examples of polynomial equations used in chemistry; Numerical differentiation – finite difference method (backward, central and forward), Numerical integration - Trapezoidal and Simpson's rule to calculate area under the curves for chemistry problems, e.g., entropy calculations, Simultaneous equations, Statistical analysis- mean, variance, standard deviation, error, Curve fitting – linear regression, Solving Schrödinger's equation using Python packages.	

SUGGESTED READINGS:

1. Tanenbaum, A. S., & Austin, T. Structured Computer Organization. Pearson Education, London, 2012.
2. Norton, P. Peter Norton's Introduction to Computers. McGraw-Hill, New York, 2006.
3. Silberschatz, A., Galvin, P. B., & Gagne, G. Operating System Concepts. Wiley, Hoboken, NJ, 2018.
4. Nutt, G. J. Operating Systems: A Modern Perspective. Addison-Wesley, Boston, 1997.
5. Balagurusamy, E. Programming in ANSI C. McGraw-Hill Education, New Delhi, 2019.
6. Oliphant, T. E. A Guide to NumPy. Continuum Press, Austin, TX, 2006.
7. McKinney, W. Python for Data Analysis. O'Reilly Media, Sebastopol, CA, 2022.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
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NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Degree	**Year**: 3	**Semester**: VI
Subject: CHEMISTRY		
Course Code: BSCY-605	**Course Title: Quality Assurance and Control**	

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamentals of quality
2. Familiarize with Total Quality Management
3. Provide knowledge of Quality Management Systems
4. Introduce the regulatory environment
5. Develop skills in standard operating procedures (SOPs)
6. Teach calibration and validation techniques
7. Promote proper sampling and sample management.

Course Learning Outcomes

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

- Define quality, QA, and QC
- Describe the importance of quality in chemical industries
- Apply Total Quality Management principles
- Understand Quality Management Systems
- Explain regulatory guidelines
- Develop and follow SOPs .
- Perform instrument calibration.
- Conduct method validation
- Utilize reference materials
- Manage sampling procedures effectively

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0

Unit	**Topics**	**Total No. of Lectures**

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

I	**Introduction to Quality Concepts** Basic Concepts, Definition of Quality, Quality Assurance (QA), Quality Control (QC). Difference between QA and QC. Importance of Quality in chemical industries (pharmaceuticals, food, environmental, materials, etc.). Total Quality Management (TQM): Principles and benefits.	
II	**Quality Management Systems (QMS):** Introduction to ISO 9000 series (overview and relevance to chemistry). ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories. NABL (National Accreditation Board for Testing and Calibration Laboratories) accreditation.	
III	**Regulatory Environment:** Introduction to Good Laboratory Practices (GLP). Introduction to Good Manufacturing Practices (GMP). Brief overview of ICH (International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use) guidelines (e.g., ICH Q2 for analytical method validation).	
IV	Quality Control in Analytical Laboratories **Standard Operating Procedures (SOPs):** Importance and development of SOPs for various laboratory operations (sample handling, reagent preparation, instrument operation, data recording). **Calibration and Validation:** Calibration: Principles of instrument calibration (e.g., pH meter, analytical balance, spectrophotometer). Calibration curves. Method Validation: Parameters for analytical method validation (accuracy, precision, linearity, range, specificity, robustness, LOD, LOQ).Reference materials and certified reference materials (RMs and CRMs).Sampling and Sample Management: Importance of proper sampling techniques. Sampling plans and representativeness. Sample preparation and preservation.Chain of Custody.	

SUGGESTED READINGS:

1. Juran, J. M., & Godfrey, A. B. Juran's Quality Handbook. McGraw-Hill Education, New York, 1999.
2. Oakland, J. S. Total Quality Management and Operational Excellence: Text with Cases. Routledge, London, 2014.
3. Hoyle, D. ISO 9000 Quality Systems Handbook. Routledge, London, 2018.
4. Walsh, A. ISO 9000: Quality Management Systems – Standards and Guidelines. Prentice-Hall, Upper
5. SaddlWillig, S. H., Stoker, J. R., & Tuckerman, M. M. Good Manufacturing Practices for Pharmaceuticals. CRC Press, Boca Raton, FL, 2001.

6. Gorog, S. Validation in Pharmaceutical Analysis: Progress and Challenges. CRC Press, Boca Raton, FL, 2010e River, NJ, 2002.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Degree	**Year**: 4	**Semester**: VII
Subject: CHEMISTRY		
Course Code: BSCY-704	**Course Title: Research Methodology**	

Course Objectives:

The objectives of this course are to:

Introduce the fundamentals of research – Explain the research process, including defining problems, literature review, hypothesis formulation, experimental design, data collection, analysis, interpretation, and reporting.

Develop literature survey skills – Teach students to identify and use primary, secondary, and tertiary sources, including print and digital databases.

Familiarize with research metrics – Explain impact factor, h-index, i10 index, altmetrics, citation indices, and author identifiers like ORCID and Publons.

Enhance scientific communication skills – Cover types of technical documents, thesis writing, use of software tools (Word, LaTeX, Chemdraw, ChemSketch), referencing styles, and citation management

tools (Mendeley, Zotero, Endnote).

Develop oral and visual presentation skills – Teach planning and preparing effective oral presentations and posters using software tools and visual aids.

Introduce statistical analysis in chemistry research – Explain data types, collection methods, hypothesis testing, distributions, significance tests (t-test, F-test, chi-square, ANOVA), regression, and correlation.

Familiarize with computational tools for data analysis – Introduce Microsoft Excel, Origin, and SPSS for processing and interpreting research data.

Promote research ethics and effective reporting – Emphasize accuracy, clarity, reproducibility, and ethical reporting in scientific research.

Course Learning Outcomes
Upon successful completion of this course, students will be able to:

Define and design a research problem – Identify research gaps, formulate hypotheses, and design appropriate experimental/research methods.

Conduct effective literature surveys – Locate and utilize relevant information from journals, books, e-databases, and digital repositories.

Evaluate research impact – Interpret journal metrics, citation indices, and author profiles to assess research quality and relevance.

Write scientific documents effectively – Prepare research papers, theses, project proposals, short communications, and reviews with proper structure, language, and referencing.

Use software tools for documentation – Utilize Word, LaTeX, ChemDraw, ChemSketch, and citation managers (Mendeley, Zotero, EndNote) to prepare accurate and well-formatted scientific documents.

Plan and deliver effective presentations – Develop oral presentations and posters using software tools and visual aids to communicate scientific findings clearly.

Collect and analyze research data – Apply suitable data collection methods and statistical techniques for hypothesis testing and interpretation of results.

Perform statistical tests – Conduct t-tests, F-tests, chi-square tests, ANOVA, regression, and correlation analysis on chemical and experimental data.

Use computational tools for data analysis – Employ Microsoft Excel, Origin, and SPSS for data visualization, processing, and statistical interpretation.

Apply research ethics and integrity – Ensure accuracy, reproducibility, and ethical standards in scientific writing, data handling, and publication.

Course Learning

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0	

Unit	Topics	Total No. of Lectures
I	**Scope of Research** Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.	
II	**Literature Survey, Databases and Research metrics** Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN	
III	**Communication in Science** Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis. Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chemsketchetc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.	
IV	**Statistical analysis for chemists** Types of data, data collection-Methods and tools, data processing, hypothesis testing, Normal and Binomial distribution, tests of significance: t-test, F-test,	

	chi- square test, ANOVA, multiple range test, regression and correlation. Features of data analysis with computers and softwares -Microsoft Excel, Origin, SPSS	

SUGGESTED READINGS:

1.Kothari, C. R., & Garg, G. Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi, 2019.

2. Creswell, J. W., & Creswell, J. D. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Thousand Oaks, CA, 2018.

3. Booth, W. C., Colomb, G. G., & Williams, J. M. The Craft of Research. University of Chicago Press, Chicago, IL, 2016.

4. Hart, C. Doing a Literature Review: Releasing the Research Imagination. SAGE Publications, London, 2018.

5. Day, R. A., & Gastel, B. How to Write and Publish a Scientific Paper. Cambridge University Press, Cambridge, 2016.

6. Alley, M. The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid. Springer, New York, 2013.

7. Montgomery, S. L. The Chicago Guide to Communicating Science. University of Chicago Press, Chicago, IL, 2017.

8. Miller, J. N., & Miller, J. C. Statistics and Chemometrics for Analytical Chemistry. Pearson Education, Harlow, 2018.

9. Harris, D. C. Quantitative Chemical Analysis. W. H. Freeman and Company, New York, 2020.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15): -Project / Seminar / Quiz / Presentation/ Assignment: -Attendance & Conduct: -Total	15 Marks 10 Marks 05 Marks 30 Marks

Programme / Class: Undergraduate Degree	**Year**: 4	**Semester**: VIII
Subject: CHEMISTRY		
Course Code: BSCY-802	**Course Title: Research Publications and Ethics**	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Course Objectives: **Course Learning Outcomes:**		
Credits: 4	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 4-0-0		
Unit	**Topics**	**Total No. of Lectures**
I	**Philosophy and Ethics:** Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions.	
II	**Scientific Conduct:** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. (8 Lectures) Publication Ethics: Publication ethics: definition, introduction, and importance. Best practices /standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributorship. Identification of publication misconduct, complaints, and appeals. Predatory publishers and journals.	
III	**HANDS ON SESSIONS on Open Access Publishing:** 1. Open access publications and initiatives 2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies 3. Software tool to identify predatory publications developed by SPPU 4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.	
IV	**Publication Misconduct:** A. Group Discussions 1. Subject specific ethical issues, FFP, authorship 2. Conflicts of interest 3. Complaints and appeals: examples and fraud from India and abroad B. Software tools 118 Use of plagiarism software like Turnitin, Urkund and other open source software tools	

V	**Databases and Research Metrics:** **A. Databases** 1. Indexing databases 2. Citation databases: Web of Science, Scopus, etc **B. Research Metrics** 1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score 2. Metrics: h-index, g index, i10 index, altmetrics .	

SUGGESTED READINGS:

1. Thiroux, J. P., & Krasemann, K. W. Ethics: Theory and Practice. Pearson Education, Boston, MA, 2015.
2. O'Connor, D. J. An Introduction to the Philosophy of Education. Routledge, London, 2003.
3. Shamoo, A. E., & Resnik, D. B. Responsible Conduct of Research. Oxford University Press, Oxford, 2015.
4. Elliott, K. C., & Resnik, D. B. Science, Policy, and the Value-Free Ideal. Oxford University Press, Oxford, 2017.
5. Steneck, N. H., Mayer, T., & Anderson, M. S. Research Integrity and Misconduct: A Global Approach. World Scientific Publishing, Singapore, 2019.
6. Pecorari, D. Academic Writing and Plagiarism: A Linguistic Analysis. Bloomsbury Academic, London, 2013.
7. Bretag, T. (Ed.). Handbook of Academic Integrity. Springer, Singapore, 2016.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: I
Subject: CHEMISTRY		
Course Code: M-DIS-FCP	**Course Title:** Chemistry of Foods, Cosmetics and Perfumes	
Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	Topics	Total No. of Lectures
I	**Food:** Food Processing and Food Adulteration Food processing: Introduction, methods for food processing, additives and preservatives. Food processing- impact on nutrition, analysis of calcium in milk by complexometric titration, spectrophotometric analysis of iron in foods, Spectrophotometric identification and determination of caffeine and benzoic acid in soft drinks. Field Work -Visit to Food Industries. Food adulteration: Adulterants in some common food items and their identification: Pulses, chilli powder, turmeric powder, milk, honey, spices, food grains and wheat flour, coffee powder, tea leaves, vegetable oil, ghee, ice creams, tomato sauce. Field Work-Collection of adulterated food samples, demonstration of a minimum of five experiments for testing adulterants in food items.	
II	**Cosmetics:** A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntanlotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

III	**Perfumes:** Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol,sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	

SUGGESTED READINGS:

1. Fellows, P. J. Food Processing Technology: Principles and Practice. Woodhead Publishing, Cambridge, 2017.
2. Potter, N. N., & Hotchkiss, J. H. Food Science. Springer, Boston, MA, 1998.
3. Vaclavik, V. A., & Christian, E. W. Essentials of Food Science. Springer, New York, 2014.
4. Smith, J. S., & Hui, Y. H. Food Processing: Principles and Applications. Wiley-Blackwell, Hoboken, NJ, 2004.
5. Ranganna, S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill Education, New Delhi, 2011.
6. Sethi, P. D. Identification of Drugs and Pharmaceutical Formulations by Thin Layer Chromatography. CBS Publishers, New Delhi, 2018.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: II
Subject: CHEMISTRY		
Course Code: M-DIS-EL	**Course Title:** Chemistry in Everyday Life	
Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	Topics	Total No. of Lectures
I	**Food additives** Functional food additives and its importance, food adulteration, detection of food adulterations, food safety laws and fssai regulations. Food colours-permitted and non-permitted – Flavours – natural and synthetic, artificial sweeteners, toxic effect of additives.	
II	**Soaps and Detergents** Soaps and Detergents – saponification, classification, cleansing action of soap, manufacturing process, additives, fillers, flavours, bleaching agents and enzymes used in commercial detergents, environmental hazards.	
III	**Cosmetics and perfumes** Cosmetics and perfumes – classification, ingredients and regulations, bathing oils, face creams, talcom powder, skin products, hair dyes, shaving cream, shampoo, conditioners, nail polish, deodorants, antiperspirants, oral hygiene products, toxic effect of cosmetics.	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

IV	**Glasses and ceramics** Glasses and ceramics – classification, manufacturing process, composition and properties of glasses, soda glass, borosilicate glass, coloured glass, photosensitive glass, armoured glass, safety glass, Important clays and fledspar, plasticity of clay, ceramic and its types, white pottery, glazing, applications.	
V	**Plastics in daily use Plastics in daily use** Polymerization process (brief). Thermosetting and thermoplastic polymers. Use of PET, HDPE, PVC, LDPE, PP, PS, ABS, and others. Recycling of plastics. Biodegradable plastics. Environmental Hazards of plastics. Paper news print, writing paper, paper boards, cardboards. Organic materials, wood, cotton, Jute, coir – International Universal recycling codes and symbols for identification	

SUGGESTED READINGS:

1. Smith, J. S., & Hong-Shum, L. Food Additives Data Book. Wiley-Blackwell, Oxford, 2011.
2. Mortimer, D. Food Additives: An Introduction. Springer, Dordrecht, 2018.
3. Marriott, N. G., & Schilling, M. W. Principles of Food Sanitation. Springer, Cham, 2018.
4. Skoog, D. A., Holler, F. J., & Crouch, S. R. Principles of Instrumental Analysis. Cengage Learning, Boston, MA, 2018.
5. Indian Food Safety and Standards Authority (FSSAI). Manual of Methods of Analysis of Foods: Food Additives. FSSAI, New Delhi, 2016.
6. Kumar, S., & Sharma, S. Industrial Chemistry: Including Chemical Engineering. Goel Publishing House, Meerut, 2014.
7. Norris, C. R., & Norris, R. E. Soaps and Detergents. Longmans, London, 1964.
8. De Guzman, M. R. T. Surfactants and Detergents: Chemistry, Properties and Applications. Nova Science Publishers, New York, 2018.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Diploma	**Year**: 2	**Semester**: III
Subject: CHEMISTRY		
Course Code: M-DIS-IMC	**Course Title:** Introduction to Material Chemistry	
Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	Topics	Total No. of Lectures
I	**Polymers** Introduction to polymers; ideal and Flory chains; the theta temperature and coil-globule transitions; viscoelasticity of polymers; determination of molecular weights of polymers by different experimental techniques.	
II	**Surfactants** Surface tension, adsorption, surface excess and surfactants; different types of surfactants; self-assembled structures; phase diagrams	
III	**Colloids** Stability of colloidal suspensions – the DLVO theory; colloidal interactions; engineering phase behaviour; thermodynamics and kinetics of phase transitions in certain colloidal model systems.	
IV	**Liquid Crystals** Introduction to mesophases**;** concepts of order parameters; theories of phase transitions in the context of liquid crystals; experimental techniques in characterising mesophases and phase transitions in liquid crystals; basics of liquid crystal displays.	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

V	**Nanomaterials and Advanced functional Materials** Fundamentals of nano science: definition, nano versus bulk, quantum confinement: nanoscale in 1D, 2D and 3D with examples, synthesis of nano materials: top-down and bottom-up approaches, size and shape dependent optical properties of semiconductive (CdSe) and 110 plasmonic metal nanoparticles, nanoclusters and nanowires, nanoparticles, concept of magnetic nanoparticles, applications of nanomaterials.	
VI	**Characterization of Nanomaterials** Introduction to surface spectroscopy, Microscopy, problems of surface analysis, Fundamental principles, Instrumentation and applications: Fourier-transform infrared spectroscopy, Brunauer-Emmett-Teller (BET) surface area, X-ray photoelectron spectroscopy (XPS), X-ray powder diffraction, Transmission electron microscopy image, Scanning electron microscopy (SEM), Atomic Force Microscopy (AFM), Energy dispersive X-ray spectroscopy (EDS), Temperature programmed desorption, Temperature programmed reduction (TPR), Secondary Ion Mass Spectroscopy (SIMS).	

SUGGESTED READINGS:

1. Gowariker, V. R., Viswanathan, N. V., & Jayadev Sreedhar. Polymer Science. New Age International Publishers, New Delhi, 2015.
2. Young, R. J., & Lovell, P. A. Introduction to Polymers. CRC Press, Boca Raton, FL, 2011.
3. Rosen, M. J., & Kunjappu, J. T. Surfactants and Interfacial Phenomena. Wiley, Hoboken, NJ, 2012.
4. Tadros, T. F. Applied Surfactants: Principles and Applications. Wiley-VCH, Weinheim, 2005.
5. Lagerwall, J. P. F., & Scalia, G. A New Era for Liquid Crystal Research: Applications of Liquid 6. Crystals in Soft Matter Nano-, Bio- and Microtechnology. Current Applied Physics, Elsevier, Amsterdam, 2012.
7. Bandyopadhyay, A. K. Nano Materials. New Age International Publishers, New Delhi, 2017.
8. Willard, H. H., Merritt, L. L., Dean, J. A., & Settle, F. A. Instrumental Methods of Analysis. CBS Publishers, New Delhi, 2013.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: I
Subject: CHEMISTRY		
Course Code: SEC-FP	**Course Title:** Fuel and Pharmaceutical Chemistry	
Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	Topics	Total No. of Lectures
I	**Classification of fuels and their calorific value.** Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining. Composition of crude petroleum, Refining and different types of petroleum products and their applications.	
II	**Petroleum and Petrochemical Industry**: Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

III	**Drugs & Pharmaceuticals** Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine). Fermentation Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	

SUGGESTED READINGS:

1. Gupta, O. P. Elements of Fuels, Furnaces and Refractories. Khanna Publishers, New Delhi, 2010.
2. Sharma, B. K. Industrial Chemistry: Including Chemical Engineering. Goel Publishing House, Meerut, 2013.
3. Speight, J. G. The Chemistry and Technology of Coal. CRC Press, Boca Raton, FL, 2020.
4. Wiseman, P. Petrochemicals: The Rise of an Industry. John Wiley & Sons, New York, 1986.
5. Silverman, R. B., & Holladay, M. W. The Organic Chemistry of Drug Design and Drug Action. Academic Press, London, 2014.
6. Moo-Young, M. Comprehensive Biotechnology. Elsevier, Amsterdam, 2011.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Programme / Class: Undergraduate Certificate	**Year**: 1	**Semester**: II
Subject: CHEMISTRY		
Course Code: SEC-WTA	**Course Title:** Water Treatment and Analysis	
Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		

Unit	Topics	Total No. of Lectures
I	**Water Quality** Parameters and Purification Characteristics of water, alkalinity. Hardness: unit of hardness, total solids, oxidation, transparency, silica content. Purification of water for drinking purpose: potability of water, clarification, coagulation, contact and electro chemical coagulation, sterilization and disinfection of water, precipitation, aeration, ozonisation, chlorination.	
II	**Water Treatment** Water softening methods: Clark's process, lime soda process, modified lime soda process, permutit or zeolite process, ion exchange process, demineralization of water. Determination of hardness of water: titration method, complexometric method using EDTA. Expressing hardness: equivalents of calcium carbonate. Problems to determine temporary and permanent hardness.	
III	**Hard Water and their Treatment** Hard water and industries, industrial water treatment, boiler feed water method of softening, prevention of plumbo solvency, scales in boilers and consequences, internal conditioning methods. Desalination of brackish water: elecrodialysis, reverse osmosis, removal of Fe, Mn and silicic acid, effluent treatment of water from paper industry, petrochemical, fertilizer industry and power station.	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

IV	**Analysis of Water** Analysis of chemical substances affecting health: NH3, nitrate, nitrite, cyanide, sulphate, sulphide, chloride, fluoride. Measurement of toxic chemical substances, analysis of chemical substances indicative of pollution, dissolved oxygen, bio chemical oxygen demand (BOD), chemical oxygen demand (COD). Bacteriological examination of water: total count test, E-coli test, E-coli index, most probable number method, biological examination of water, physical examination of water. Radioactivity of water: methods of removing radioactivity from water.	

SUGGESTED READINGS:

1. Manahan, S. E. Environmental Chemistry. CRC Press, Boca Raton, FL, 2018.
2. Davis, M. L., & Masten, S. J. Principles of Environmental Engineering and Science. McGraw-Hill, New York, 2014.
3. Pontius, F. W. Water Quality and Treatment: A Handbook on Drinking Water. McGraw-Hill, New York, 2013.
4. Droste, R. L., & Gehr, R. L. Theory and Practice of Water and Wastewater Treatment. Wiley, Hoboken, NJ, 2018.
5. Jain, P. C., & Jain, M. Engineering Chemistry. Dhanpat Rai Publishing, New Delhi, 2015
6. Tchobanoglous, G., Burton, F. L., & Stensel, H. D. Wastewater Engineering: Treatment, Disposal and Reuse. McGraw-Hill, New York, 2003.
7. Eaton, A. D., Clesceri, L. S., Rice, E. W., & Greenberg, A. E. Standard Methods for the Examination of Water and Wastewater. American Public Health Association (APHA), Washington, DC, 2005.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

Programme / Class: Undergraduate Diploma	**Year**: 2	**Semester**: III
Subject: CHEMISTRY		
Course Code: SEC-EC	**Course Title: Elementary computer applications softwares**	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

Course Objectives: **Course Learning Outcomes:**		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70 = 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:** 3-0-0		
Unit	**Topics**	**Total No. of Lectures**
I	**Computer Fundamentals:** Hardware and Software: Understanding the basic components of a computer (CPU, memory, storage) and the difference between system software (operating systems) and application software. Operating Systems: Familiarization with common operating systems like Windows, including basic navigation, file management, and settings. Number Systems: Introduction to binary, decimal, and hexadecimal number systems and their conversions. Data Representation: Understanding how data is represented in computers, including character encodings (ASCII, Unicode). Internet and its Uses: Basic internet concepts, browsing, searching, and communication (email, etc.).	
II	**Software Applications:** Word Processing (Microsoft Word): Creating, editing, formatting documents, working with tables, inserting images, and using mail merge. Spreadsheets (Microsoft Excel): Creating spreadsheets, entering data, using formulas and functions, creating charts and graphs, and data analysis. Presentations (Microsoft PowerPoint): Creating presentations, adding slides, using text, images, and animations. Specialized Software (for Chemistry): Introduction to software used for chemical calculations, data analysis, molecular modeling, or simulation (e.g., ChemDraw, Gaussian, Avogadro	

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut

III	**Programming Concepts (Optional, depending on the depth of the course):** Introduction to Programming: Basic programming concepts, algorithms, and flowcharts. Programming Languages (Optional): A brief introduction to programming languages used in scientific computing, such as Python.	
IV	**Digital Education and Online Resources:** Digital Education: Understanding the role of computers in online learning and access to educational resources. Online Resources for Chemistry: Utilizing online databases, journals, and other resources for research and learning in chemistry.	
V	**Ethical Considerations:** Responsible Use of Technology: Understanding the ethical implications of using computers and software, including issues of data privacy, security, and plagiarism.	

SUGGESTED READINGS:

1. Leon, A., & Leon, M. Fundamentals of Information Technology. Vikas Publishing House, New Delhi, 2011.
2. Rajaraman, V., & Adabala, N. Fundamentals of Computers. Prentice-Hall of India, New Delhi, 2018.
3. Silberschatz, A., Galvin, P. B., & Gagne, G. Operating System Concepts. Wiley, Hoboken, NJ, 2018.
4. Stallings, W. Operating Systems: Internals and Design Principles. Pearson Education, London, 2018.
5. Kurose, J. F., & Ross, K. W. Computer Networking: A Top-Down Approach. Pearson Education, Boston, MA, 2017.
6. Forouzan, B. A. Data Communications and Networking. McGraw-Hill Education, New York, 2017.

Components for Continuous Internal Assessment (CIA) for practical course:	
-One Mid Semester Written Test (1x15):	15 Marks
-Project / Seminar / Quiz / Presentation/ Assignment:	10 Marks
-Attendance & Conduct:	05 Marks
-Total	30 Marks

K V Subharti College of Science
S V Subharti University
NH-58 Byepass Road, Meerut