National Education Policy-2020

Common Minimum Syllabus for Uttarakhand State Universities and Colleges

Three Year Undergraduate Programme

Bachlor in Science

(1st to 6th Semester)

w. e. f. - 2025-2026

DEPARTMENT OF CHEMISTRY

KUMAUN UNIVERSITY, NAINITAL

29.06.2025
HEAD
DEPARTMENT OF CHEMISTRY
KUMAUN UNIVERSITY NAINITAL

29.06.2025
Dean
Faculty of Science
Kumaun University
Nainital

SYLLABUS PREPARATION COMMITTEE

S.N.	NAME	DESIGNATION	DEPARTMENT	AFFILIATION
1.	Dr. Chitra Pande	Professor, Head & Convenor	Chemistry	Kumaun University Nainital
2.	Dr. Nand Gopal Sahoo	Professor	Chemistry	Kumaun University Nainital
3.	Dr. Geeta Tewari	Professor	Chemistry	Kumaun University Nainital
4.	Dr. Shah Raj Ali	Professor	Chemistry	Kumaun University Nainital
5.	Dr. Suhail Javed	Associate Professor	Chemistry	Kumaun University Nainital
6.	Dr. Mahesh C. Arya	Assistant Professor	Chemistry	Kumaun University Nainital
7.	Dr. Manoj Dhuni	Assistant Professor	Chemistry	Kumaun University Nainital
8.	Dr. Penny Joshi	Assistant Professor	Chemistry	Kumaun University Nainital
9.	Dr. Lalit Mohan	Assistant Professor (Contractual)	Chemistry	Kumaun University Nainital
10.	Dr. Girish C. Kharkwal	Assistant Professor (Guest)	Chemistry	Kumaun University Nainital
11.	Dr. Deepshikha Joshi	Assistant Professor (Guest)	Chemistry	Kumaun University Nainital
12.	Miss. Anchal Aneja	Assistant Professor (Guest)	Chemistry	Kumaun University Nainital
13.	Dr. Akanksha Rani	Assistant Professor (Guest)	Chemistry	Kumaun University Nainital
14.	Dr. Bhawana Pant	Assistant Professor (Guest)	Chemistry	Kumaun University Nainital

SYLLABUS REVIEW COMMITTEE

S.N.	NAME	DESIGNATION	DEPARTMENT	AFFILIATION
1.	Dr. K. R. Prabhu	Professor	Chemistry	Indian Institute of Science, Bengaluru
2.	Dr. Robina Aman	Professor	Chemistry	S. S. J. University Almora
3.	Dr. Neeta Joshi	Professor	Chemistry	Sri Dev Suman Uttarakhand University, Garhwal
4.	Dr. Beena Negi	Assistant Professor	Chemistry	Gargi College, University of Delhi, Delhi

National Education Policy-2020
Common Minimum Syllabus for all Uttarakhand State Universities/ Colleges
SUBJECT: CHEMISTRY

Multidisciplinary Courses of Study [Three core Disciplines]								
Semester	Core (DSC)	Elective (DSE)	Generic Elective (GE)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Apprenticeship/ Project	Value Addition Course (VAC)	Total Credits
I	Discipline A1-(4) Discipline B1-(4) Discipline C1-(4)		Choose one from a pool of courses GE-1(4)	Choose one from a pool of AEC courses (2)	Choose one from a pool of courses (2)		Choose one from a pool of courses (2)	22 credits
II	Discipline A2-(4) Discipline B2-(4) Discipline C2-(4)		Choose one from a pool of courses GE-2(4)	Choose one from a pool of AEC courses (2)	Choose one from a pool of courses (2)		Choose one from a pool of courses (2)	22 credits
	Students on exit shall awarded Undergraduate Certificate (in the field of Multidisciplinary Study) after securing the requisite 44 credits in Semester I and II							Total=44 credits
III	Discipline A3-(4) Discipline B3-(4) Discipline C3-(4)	Choose from pool of courses DSE A/B/C (4) **OR** Choose from pool of course GE-3(4)		Choose one from a pool of AEC courses (2)	Choose one SEC (2)		Choose one from a pool of courses (2)	22 credits
IV	Discipline A4-(4) Discipline B4-(4) Discipline C4-(4)	Choose from pool of courses DSE A/B/C (4) **OR** Choose from pool of course GE-4(4)		Choose one from a pool of AEC courses (2)	Choose one SEC (2)		Choose one from a pool of courses (2)	22 credits
	Students on exit shall awarded Undergraduate Diploma (in the field of Multidisciplinary Study) after securing the requisite 88 credits in Semester III and IV							Total=88 credits
V/Third Year	Discipline A5-(4) Discipline B5-(4) Discipline C5-(4)	Choose from pool of courses DSE A/B/C (4) **OR** Choose from pool of course GE-5(4)			Choose one SEC (2)	Internship/ Apprenticeship/ Project/ Community outreach / Field Work(4)		22 credits
VI	Discipline A6-	Choose from pool of			Choose one	Internship/		22

/ Third Year	(4) Discipline B6-(4) Discipline C6-(4)	courses DSE A/B/C (4) **OR** Choose from pool of course GE-6(4)		SEC (2)	Apprenticeship/ Project/ Community outreach / Field Work(4)		credits
	Students on exit shall awarded Bachelor (in the field of Multidisciplinary Study) after securing the requisite 132 credits in Semester V and VI						Total=132 credits

Contents

List of Papers (DSC, DSE, GE) with Semester Wise Titles for 'Chemsirty'					
Year	**Semester**	**Course**	**Paper Title**	**Theory/Practical**	**Credits**
Undergraduate Certificate in Chemistry					
FIRST YEAR	I	DSC 1	Fundamentals of Chemistry-I	Theory	3
			Chemical Analysis-I	Practical	1
		GE 1	Basics of Chemistry- I	Theory	4
	II	DSC 2	Fundamentals of Chemistry-II	Theory	3
			Chemical Analysis-II	Practical	1
		GE 2	Basics of Chemistry- II	Theory	4
Undergraduate Diplomain Chemistry					
SECOND YEAR	III	DSC 3	GeneralChemistry-I	Theory	3
			Chemical Analysis-III	Practical	1
		DSE 3	Environmental Chemistry	Theory	4
		GE 3	Basics of Chemistry- III	Theory	4
	IV	DSC 4	General Chemistry-II	Theory	3
			Chemical Analysis-IV	Practical	1
		DSE 4	Chemistry of Biomolecules	Theory	4
		GE 4	Basics of Chemistry- IV	Theory	4
Bachelor of Chemistry					
THIRD YEAR	V	DSC 5	Inorganic & Organic Chemistry	Theory	3
			Chemical Analysis-V	Practical	1
		DSE 5	Analytical Methods in Chemistry	Theory	4
		GE 5	Basics of Chemistry- V	Theory	4
		IAPT 5	Internship/ Apprenticeship/Academic Project/Applied Project/Field Work/Training		4
	VI	DSC 6	Physical & Analytical Chemistry	Theory	3
			Chemical Analysis-VI	Practical	1
		DSE 6	General Analytical Techniques	Theory	4
		GE 6	Basics of Chemistry- VI	Theory	4
		IAPT 6	Internship/ Apprenticeship/Academic Project/Applied Project/Field Work/Training		4

Abbreviations- DSC-Discipline Specific Course; DSE- Discipline Specific Electives; GE-Generic Electives

Pattern of examination

A. Theory

Each theory paper shall be of 03 hours and will consist of two sections, A and B. Section A: (Short answers type with reasoning); 40% of the total marks (30 marks, eight questions of six marks each, any five have to be attempted). Section B: (Long answers type); 60 % of the total marks, (45 marks, three questions out of five have to be attempted. Each question carries 15 marks).

B. Internal assessment

For each theory paper, an internal assignment (in the form of class test and or assignments including classroom attendance) of 25 marks for each paper shall be conducted during each semester. The evaluated answer sheets/assignments have to be submitted to the Head of the Department/ Principal along with one copy of award list. The marks obtained have to be uploaded onto the University examination portal and the print out of the award list from portal have to be submitted to the Controller Examination.

C. Practical

The practical work of the students has to be evaluated periodically. The internal assessments (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 25 marks for each semester shall be conducted during the semester. In each semester, practical examination of 75 marks has to conducted by two examiners (External and internal) having duration of two days (time 6 hours each day). The external examiner will examine the students only on the second day of examination. The total number of students to be examined per batch should not be more than sixty. One copy of award list of the practical examination along with attendance has to be submitted to the Head of the Department/ Principal. The marks obtained have to be uploaded onto the University examination portal and the print out of the award list from portal have to be submitted to the Controller Examination.

Programme Specific Outcomes (PSOs) (Undergraduate Programme) **After this programme, the learners will be able to:**	
PSO1	Basic knowledge of all the fundamental principles of chemistry like atomic structure, molecular polarity.
PSO2	Develop an understanding ofbonding theories of different molecules, resonance concept, hyperconjugation, field effects, periodic properties of more than 111 elements, mechanism of organic reactions, stereochemistry.
PSO3	Acquire Knowledge about detailed study of states of matter including kinetic theories of gases, solid and liquid states, chemistry of aliphatic and aromatic compounds, chemical kinetics, its scope and first law of thermodynamics.
PSO4	Able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory.
PSO5	Acquire specialized knowledge about handling chemicals, apparatus, equipment and instruments.
PSO6	Acquire knowledge about second law of thermodynamics, chemical equilibrium, phase equilibrium, electrochemistry.
PSO7	Able to understand coordination chemistry, acid-base theories, chemistry of transition elements, halides, alcohols, phenols, aldehydes, ketones and carboxylic acids.
PSO8	Enhance the skill of the students regarding chemical and physical tests of inorganic as well as organic compounds along with some physical experiments
PSO9	Develop understanding about chemistry of nitrogen containing compounds, organometallic, lipids, fats, dyes, reagents in organic synthesis, carbohydrates, proteins, biomolecules, data analysis, nano-chemistry, green chemistry.
PSO10	Students will able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments.

Semester-I

Undergraduate Certificate in Chemistry

DISCIPLINE SPECIFIC COURSE (DSC 1)
Fundamentals of Chemistry-I
Chemical Analysis-I (Practical)

No. of Hours -75

CREDITDISTRIBUTION, ELIGIBILITY ANDP RE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Fundamental of Chemistry-I (Theory) Chemical Analysis-I (Practical)	**4**	**3**	**0**	**1**	**Passed Class XII with Chemistry**	**Nil**

UNDERGRADUATE CERTIFICATE IN CHEMISTRY		
Programme: Undergraduate Certificate in Chemistry	**Year: I**	**Semester: I** **Paper: DSC 1**
Subject: Chemistry		
Course: DSC (Theory)	**CourseTitle: Fundamentals of Chemistry-I**	

Course Outcomes:

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

- Learn about atomic structure, periodic properties and shapes of molecules. Understanding these concepts enables students to predict the physical and chemical properties of molecules.
- Gain the knowledge of different bonding theories such as VSEPR and Valence Bond Theory, which are essential for predicting molecular structures and bonding parameters.
- Understand about the organic reaction mechanisms, including types of reactions, reactive intermediates and stereochemistry
- Understand about the intermolecular forces, law governing ideal gases, and methods for determining physical properties.
- Understand about the nature of material, space lattice, miller indices, law governing crystallography.
- Understand about colloids, types of colloids, and properties relating to it.

Fundamentals of Chemistry-I	
Credits: 3	**DisciplineSpecific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Atomic Structure and Periodic Properties:** Heisenberg uncertainty principle; its significance. Atomic orbitals, Quantum numbers, shapes of s, p and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum	

	multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements). Effective nuclear charge. The general idea of Modern periodic table, atomic and ionic radii, ionization potential, electron affinity, electronegativity-definition, trends of variation in periodic table and factors affecting periodic properties.	**10**
Unit II	**Chemical Bonding-I**: Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of NH_3, H_2O, H_3O^+, SF_4, ClF_3, XeF_2, $XeOF_2$, $XeOF_4$, XeO_3, XeF_4). Valence Bond Theory; Hybridization and types of hybridization and shapes of different inorganic and organic molecules (CH_4, C_2H_2, C_2H_4, CO_2, SO_2, NO_3^-, BCl_3, SF_6, $BeCl_2$, PCl_5, IF_7).	**10**
Unit III	**Mechanism of Organic Reactions:** Types of reagents- electrophiles and nucleophiles. Resonance, hyperconjugation, field effects- inductive, mesomeric, electromeric effect. Types of organic reactions: Substitution. Addition, rearrangement, elimination. Reactive intermediates- carbocations, carbanions, free radicals (with examples). **Stereochemistry of Organic Compounds:** Types of isomerism-optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centre, diastereomers, threo and erythro diastereomers, meso compounds. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometrical isomerism: determination of configuration of geometrical isomers, E & Z system of nomenclature.	**10**
Unit IV	**States of Matter-I:** **Solid State:** Introduction to crystalline materials, Definition of space lattice, unit cell, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry.X-ray diffraction by crystals. Bragg's equation, Numerical problems. **Gaseous State-**Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena, relationship between critical constants and van der Waals constants. qualitative discussion of the Maxwell's distribution of molecular velocities, Numerical problems. **Liquid State-**Intermolecular forces, Physical properties of liquids: Surface tension and viscosity, methods of determination of surface tension: Drop counting method, method of determination of viscosity: Ostwald viscometer method, Numerical problems. **Colloidal State:** Definition of colloids, Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.	**15**

Recommended Readings

- Concise Inorganic Chemistry byJ. D. Lee.
- Principles of Inorganic Chemistryby B. R. Puri, L.R. Sharma, and K.C. Kalia.

- Chemistry for Degree Students B. Sc. First Yearby R. L. Madan.
- Selected topics in Inorganic Chemistryby R. D. Madan, U. M. Malikand G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.
- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan.
- Stereochemistry of Organic Compounds by E. L. Eliel and S.H. Wilen.
- Organic Chemistry by I.L.Finar.
- Reaction mechanism in Organic Chemistry by S.M.Mukerji.
- Undergraduate Organic Chemistry by Jagdamba Singh, and L.D.S.Yadav.
- Physical Chemistry by D.W. Ball.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahl, and G. D. Tuli.
- Physical Chemistry by Puri, Sharma, Pathania

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Suggested equivalent online Content:

https://www.youtube.com/watch?v=q-P79gnqNR8&list=PLmUlqVgZsTVVRvO3R8gx12EMc5vmcq_c

https://www.youtube.com/watch?v=gahQYHs0c8s

https://www.youtube.com/watch?v=w2He_Q0Mf0c

https://www.youtube.com/watch?v=q1qMFcZVlPk

https://www.youtube.com/watch?v=nWTgMr6idf0

https://www.youtube.com/watch?v=JNLJyhqXaTc&t=10s

https://onlinecourses.swayam2.ac.in/cec20_lb01/preview

UNDERGRADUATE CERTIFICATE IN CHEMISTRY			
Programme: Undergraduate Certificate in Chemistry		**Year: I**	**Semester: I Paper:DSC**
Subject: Chemistry			
Course: DSC (Practical)	**CourseTitle: Chemical Analysis-I**		
Course Outcomes: After studying this course, the students will be able to: • Understand the laboratory methods and tests related to volumetric analysis. • Determine the relative surface tension of a given liquid. • Determine the absolute and relative configuration and determination of configuration of geometrical isomers.			
Chemical Analysis-I			
Credits:1			**Discipline Specific Course**
Max.Marks: As per University rules		**Min. Passing Marks: As per University rules**	
Unit	**Topic**		**No. of Hours**

Unit I	Laboratory hazards and safety precautions	**06**
Unit II	**Inorganic Exercise:** Acid-base titrations; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. For example, preparation of NaOH solution (secondary standard say N/10), preparation of $(COOH)_2$ solution (primary standard say N/10), standardization of NaOH solution titrating it against $(COOH)_2$ solution using phenolphthalein (indicator) and then determination of the strength of given HCl solution.	**08**
Unit III	**Organic exercise: Using Molecular Models:** chiral and achiral molecules Determination of Relative and Absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometrical isomerism: Using Molecular Models: determination of configuration of geometrical isomers, E & Z system of nomenclature./ **Stability of carbocation based on reaction of primary, secondary, tertiary alcohol with Lucas reagent**.	**08**
Unit IV	**Physical exercise:** Determination of relative surface tension of the given liquid using Stalagmometer.	**08**

Recommended Readings

- Stereochemistry of Organic Compounds by E.L.Eliel, and S.H. Wilen.
- Organic Chemistry by I. L. Finar.
- Vogel's Quantitative Chemical Analysis by J. Mendham.
- Quantitative Chemical Analysis by D. C. Harris.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S.M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Hollerand T. A. Nieman.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Note: Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

Semester-I

Undergraduate Certificate in Chemistry

GENERIC ELECTIVE (GE 1)
Basics of Chemistry-I

No. of Hours -60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

CourseTitle	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (ifany)
		Lecture	Tutorial	Practical/Practice		
GE: Basics of Chemistry-I	4	4	-	-	Passed Class XII	Nil

UNDERGRADUATE CERTIFICATE IN CHEMISTRY		
Programme: Undergraduate Certificate in Chemistry	**Year: I**	**Semester: I** **Paper:GE 1**
Subject: Chemistry		
Course:GE	**CourseTitle: Basics of Chemistry- I**	

Course Outcomes:

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

- Understand the important features of matter.
- Understand the difference between elements, compounds and mixtures.
- Define different types of systems, themodynamic processes, intensive and extensive properties and concenpt of heat and work.
- Understand the structure of atom by different type of models.
- Understand the basics of laboratory- Glass apparatus and types of burners.
- Able to distinguish between errors, precision and accuracy.
- Understand about the statistical tools of mean and standard deviation.

Credits:4	**Generic Elective**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Basics of Matter** Physical nature of matter, Characteristics of particles of matter, states of matter, physical and chemical changes, elements, compounds, mixtures, types of mixtures. **Properties of Matter and their Measurement**: Physical and chemical properties, The International System of Units (SI), Mass and Weight, Volume, Density, Temperature.	**10**
Unit II	**Structure of Atom** 1. **Dalton's Atomic Theory**: 2. **Discovery of Sub-atomic Particles**: Discovery of Electron, Protons and Neutrons, Charge to Mass Ratio of Electron, Charge on the Electron.	**20**

	3.**Atomic Models:** Thomson Model of Atom, Rutherford's Nuclear Model of Atom, Atomic Number and Mass Number, Isobars and Isotopes, Drawbacks of Rutherford Model 4.**Bohr's Model for Hydrogen Atom** - Explanation of Line Spectrum of Hydrogen, limitations of Bohr's Model 5. **Atomic orbitals**: Aufbau energy diagram in filling of electrons, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity.	
Unit III	**Basic Laboratory** **Glass Apparatus:** Beaker, test tube, boiling tube, conical flask, filtration flask, round bottom flask, flat bottom flask, funnel, separating funnel, watch glass. Measuring cylinder, Petridish, desiccator, measuring cylinder, glass rod, and glass tube. **Burner:** Bunsen burner, Flames of burner, Air flow regulation **Analytical approaches:** Uncertainty in Measurement- Scientific Notation, Significant Figures, Dimensional Analysis, Types of errors, precision & accuracy, absolute and relative uncertainty. Mean and standard deviation.	**15**
Unit IV	**Thermodynamics:** Definition of thermodynamic terms, system, type of system, thermodynamic processes, intensive and extensive properties, concept of heat and work.	**15**

Suggested Readings:

- Physical Chemistry by Puri, Sharma, Pathania,
- Basic Inorganic Chemistry by Ajai Kumar.
- Concise Inorganic Chemistry by J. D. Lee.
- Basic Inorganic Chemistry by F. A. Cotton, G. Wilkinson and P.L. Gaus.
- Concepts and Models in Inorganic Chemistry by B. E. Douglas, D.H. McDaniel and J. J. Alexander.
- Inorganic Chemistry: Principles of Inorganic chemistrybyHuheey, Keiter, and Medhi.
- Understanding our Chemical World by Paul Monk**.**
- Physical Chemistry by G. M. Barrow.
- Physical Chemistry by G. W. Castellan.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations

Suggestedequivalentonline content:

https://chem.washington.edu/lecture-demos/match-head-reaction
https://ncert.nic.in/textbook/pdf
https://www.youtube.com/watch?v=_AYD7YJqQ0Q&t=23s

Semester-II

Undergraduate Certificate in Chemistry

DISCIPLINE SPECIFIC COURSE (DSC 2)
Fundamentals of Chemistry-II
Chemical Analysis-II

No.of Hours -75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Fundamental of Chemistry-II (Theory) Chemical Analysis-II (Practical)	4	3	-	1	Passed B. Sc. Sem I with Chemistry (DSC 2)	Nil

UNDERGRADUATE CERTIFICATE IN CHEMISTRY

Programme: Undergraduate Certificate in Chemistry	**Year: I**	**Semester: II** **Paper: DSC 2**
Subject: Chemistry		
Course: DSC 2 (Theory)	**Course Title: Fundamentals of Chemistry-II (Theory)**	

Course Outcomes:
After studying this course, the students will be able to:

- Understand the bonding in inorganic molecules, salient features of s- and p- block elements.
- Describe the reactions shown by aliphatic and aromatic compounds.
- Different aspects of chemical kinetics, catalysis and first law of thermodynamics.

Credits: 3	**Discipline Specific Course**
Max. Marks: As Per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Chemical Bonding-II:** Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H_2, He_2, B_2, C_2, N_2, O_2, F_2, Ne_2, CO difference between VB and MO theories. Multicentre bonding in electron deficient molecules (B_2H_6); Polarizing power and polarizability; Fajan's rule. **Salient Features of s- and p-Block Elements:** General discussion with respect to all periodic (Occurrence, electronic configuration, atomic & ionic radii, density, ionization potential, metallic behaviour, electropositive nature, electronegativity, electron affinity, hydration energy, flame colouration, photoelectric effect, polarization power, boiling and melting point). Diagonal relationship, catenation, inert pair effect, pπ- pπ, chemistry of hydrides, halides,	**15**

	oxides and oxyacids of p-block elements.	
Unit II	**Aliphatic Compounds:** general methods of prepration of alkanes, Mechanism of free radical halogenation of alkanes, Pyrolysis. Preparation & Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, Epoxidation, ozonolysis, hydration and oxidation with $KMnO_4$. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydration, metal- ammonia reduction. **Aromatic Compounds:** Aromaticity- the Hückel rule, Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation. Activating and deactivating substituents.	**14**
Unit III	**Chemical Kinetics and Catalysis:** Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction–concentration, temperature, Arrhenius equation, termperature coefficient, catalyst; hetero and homocatalysis, significance. Inhibitors, poisons, promoters. Concentration dependence of rates of simple reaction, Molecularity, Order of reaction- zero order, first order, second order, pseudo-order, half-life period, Numerical problems.	**8**
Unit IV	**Thermodynamics I:** Definition of thermodynamic terms, system, surroundings etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, first law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Thermochemistry; standard state, standard enthalpy of formation. Hess's law of heat summation and its application, Numerical problems.	**8**

RecommendedReadings:

- Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K. C. Kalia.
- Chemistry for Degree Students, B. Sc. First Year by R. L. Madan.
- Selected topics in Inorganic Chemistry by R. D. Madan, U. M. Malikand G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.
- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basuand R. D. Madan.
- Organic Chemistry by I. L. Finar.
- Stereochemistry of Organic Compounds by E. L. Eliel and S. H. Wilen.
- Organic Chemistry by Boyd, Morrison and Bhattacharjee.
- Reaction mechanism in Organic Chemistry by S. M. Mukerji.
- Undergraduate Organic Chemistry by Jagdamba Singhand L. D. S. Yadav.
- Organic Chemistry by G. Marc. Loudon.
- Atkin's Physical Chemistry: International by P. W. Atkins.

- Physical Chemistry by D. W. Ball.
- Principles of Physical Chemistry by B. R. Puri, M. S. Pathania and L. R. Sharma.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahland G. D. Tuli.
- Text Book for B. Sc. Chemistry I by A. Bariyar, R. P. Singh and A. Dwivedi.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Suggested equivalent online courses:
https://www.youtube.com/watch?v=Gg4-go6tTiA&list=PLmxSS9XYst208kJs0npO_v_L-AGkHZJlS
https://www.youtube.com/watch?v=sz17_NnMPak&t=51s
https://www.youtube.com/channel/UCUxhnr9H2IYKsuRypG0MAfw/videos
https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
https://www.openlearning.com/courses/introduction-to-physical-chemistry/?cl=1
https://www.careers360.com/university/indian-institute-of-technology-bombay/chemistry-of-main-group-elements-certification-course
https://onlinecourses.swayam2.ac.in/cec20_lb01/preview
https://nptel.ac.in/courses/104/103/104103071/

UNDERGRADUATE CERTIFICATE IN CHEMISTRY		
Programme: Undergraduate Certificate in Chemistry	**Year: I**	**Semester: II** **Paper: DSC**
Subject: Chemistry		
Course: DSC(Practical)	**Course Title: Chemical Analysis-II**	

Course Outcomes:

After studying thiscourse, the students will be able to:
- To analyse inorganic salt for the presence of acidic and basic radicals.
- Systematically analyse and identify the organic compounds belonging to hydrocarbon category.
- Measure the relative viscosity of a given liquid.

Chemical Analysis- II	
Credit: 1	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As perUniversity rules**

Unit	Topic	No.of Hours
Unit I	Laboratory hazards and safety precautions	**06**
Unit II	**Inorganic exercise: Salt mixture analysis:** Identification of acidic radicals (excluding carbanions and interfering radicals) and basic radical's upto I Group in the given salt.	**08**
Unit III	**Organic exercise:** Systematic analysis and identification of any two of the following organic compounds (minimum one from each group) i. **Simple Hydrocarbons:** Napthalene, Anthracene, Biphenyl ii.**Hydrocarbons with special elements:** *m*-Dinitrobenzene, *p*-Dichlorobenzene	**08**

Unit IV	**Physical exercise**: Determination of relative viscosity of the given liquid using Ostwald viscometer. Experiment based on thermodynamic and Chemical Kinetics.	**08**

Note: Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

Recommended Readings

- Vogel's Quantitative Chemical Analysisby J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
- Laboratory Handbook of Chromatographic & Allied Methods by O. Mikes and R. A. Chalmes.
- Analytical Chemistry: Methods of separation by R. V. Ditts.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Suggested equivalent online Content:
https://www.labster.com/chemistry-virtual-labs/
https://www.vlab.co.in/broad-area-chemical-sciences
http://chemcollective.org/vlabs

Semester-II

Undergraduate Certificate in Chemistry

GENERIC ELECTIVE (GE 2)
Basics of Chemistry-II

No.of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Basics of Chemistry-II	4	4	-	-	Passed Class XII	Nil

UNDERGRADUATE CERTIFICATE IN CHEMISTRY		
Programme: Undergraduate Certificate in Chemistry	**Year: I**	**Semester: II** **Paper: GE 2**
Subject: Chemistry		
Course: GE 2	**Course Title: Basics of Chemistry-II**	

Course Outcomes:

After studying this course, the students will be able skilled to:

- Understand the concept of mole, molarity and molality
- Define periodic law and setup a relationship among the elements through atomic size, ionization energy, electron affinity, electronegativity.
- Understand the reasons for the tetravalence of carbon and shape of organic molecules write structures of organic molecules and classify the organic compounds.
- Understand the definition of pollution and various acts governing pollution control.
- Understand the environment concepts for healthy life.

Credits:4	**Generic Elective**	
Max.Marks: As per University rules	**Min. Passing Marks: As per University rules**	
Unit	**Topic**	**No. of Hours**
Unit I	**Mole Concept and Molar Masses**: Percentage composition and molecular formula, Mass percent, Mole Fraction, Molarity, Molality, PPM **Use of Measuring Equipments in sample preparation in Lab:** Apparatus as Pipette, Burette, Measuring cylinder, Volumetric flasks, Chemical balance, least count of apparatus.	**15**
Unit II	**Periodic Properties:** History of Periodic Classification: Dobereiner's triads, Newlands Octaves, Mendeleev's periodic table. Periodic table and periodic law, periodic classification of the elements, Periodic relationship among the elements, periodic properties-atomic size, ionization energy, electron affinity, electronegativity	**15**
Unit III	**Some Basic Principles of Organic chemistry** 1. **General Introduction:** Vital force theory, the origin of name 'organic chemistry', synthesis of urea in lab. 2.**Tetravalence of Carbon**: Shapes of Organic Compounds, 3. **Structural Representations of Organic Compounds**: Complete, Condensed and Bond-line, Structural Formulas. 4. **Classification of Organic Compounds**–Acyclic, open chain compounds, Cyclic, closed chain or ring compounds; Alicyclic compounds, Aromatic compounds, Functional Group, Homologous Series.	**15**
Unit IV	**Environmental pollution:** Definition of Pollutions, Major types of Pollutions, Major Sources and Effects. Functions of Pollution Control Boards; Penalties and Procedure; Duties and Responsibilities of Citizens for Environmental Protection; Environment (Protection) Act 1986; Hazardous Waste (Management and Handling) Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Public Awareness and Public Interest Litigations; Its Role in Control of Environmental Pollution in India.	**15**

Recommended Readings

- Introductory Chemistry by J. Nivaldo andHoYuAu-Yeung Tro.
- Basic Chemistry by K. C. Timberlakeand W. Timberlake.
- Green ChemistrybyV. K. Ahluwalia.

- Environmental Chemistry: A global perspective by GaryW.Vanloon and Stephen J.Duffy
- Environmental Chemistry by A. K. Day.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Semester-III

Undergraduate Diploma in Chemistry

DISCIPLINE SPECIFIC COURSE (DSC 3)
General Chemistry- I
Chemical Analysis- III

No. of Hours-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	CreditdistributionoftheCourse			Eligibility criteria	Prerequisiteof the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: General Chemistry-I	4	3	-	1	Passed Certificate in B.Sc. with Chemistry (DSC)	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diplomain Chemistry	**Year: II**	**Semester: III** **Paper: DSC 3**
Subject: Chemistry		
Course: DSC 3	**CourseTitle: General Chemistr- I**	

Course Outcomes:
After studying this course, the students will be able to:

- Detailed understanding of the d-block elements and their characteristics.
- Gather the information regarding Werner's theory and VBT of transition metal complexes.
- Provides detailed knowledge of properties of halides, alcohols and phenols highlighting their chemical reactions and their mechanism.
- Learn the basic concepts of spontaneity, chemical and phase equilibrium after that students will be able to solve the numerical problems based on these concepts.

Credits:4	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Chemistry of Transition Elements (First, second and third Transition**	

	Series): Characteristic properties of the elements; electronic configuration, atomic & ionic radii, oxidation states, ionization energy, complex compound formation, colour, and magnetic properties. Coordination number and geometry. Comparative treatment of 3d, 4d and 5d elements **Coordination Chemistry-I:** Definition, terminology (ligand, coordination number, coordination sphere, complex ion etc.), Nomenclature of coordination compounds (IUPAC system), Werner's theory for coordination compounds; its experimental verification, stability of complexes and factors contributing to the stability, Valence Bond Theory (VBT) for coordination compounds, geometry of complexes (tetrahedral, octahedral, square planar), magnetic properties of complex compounds.	**15**
Unit II	**Alkyl and aryl halides:** Preparation and comparison of their chemical properties. Mechanism of nucleophilic substitution reactions, S_N2 and S_N1 reactions with energy profile diagrams. **Alcohols and Phenols:** **Alcohols:** Preparation and chemical properties of mono hydric alcohols. General introduction of diols and triols. **Phenols:** Preparation and chemical propertiesof phenols, acidic character. Comparative acidic strengths of alcohols and phenols, Reactions of phenols. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis and Reimer-Tiemann reaction.	**12**
Unit III	**Thermodynamics II:** Second law of thermodynamics, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical and chemical processes, entropy change for reversible, irreversible and equilibrium condition. entropy as criteria of spontaneity and equilibrium. Entropychanges in ideal gases. Gibbs free energy and Helmholtz work functions. Criteria for thermodynamic equilibrium and spontaneity, advantage Gibbs free energy and Helmholtz work functions over entropy change for spontaneity, Numerical problems.	**10**
Unit IV	**Chemical Equilibrium:** The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between Kp and Kc. Le-Chatelier's principle, Numerical problems. **Phase Equilibrium:** Statement and meaning of the terms: phase, component and degree of freedom, Gibb's phase rule, phase equilibria of one component systems- water, carbon dioxide. Numerical problems	**8**

Recommended Readings

- Concise Inorganic Chemistry by J. D. Lee.
- Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K. C. Kalia.

- Chemistry for Degree Students, B. Sc. Second Year by R. L. Madan.
- Selected topics in Inorganic Chemistry by R. D. Madan, U. M. Malikand G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.
- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basuand R. D. Madan.
- Organic Chemistry by I. L. Finar.
- Stereochemistry of Organic Compounds by E. L. Eliel and S. H. Wilen.
- Organic Chemistry by Boyd, Morrison and Bhattacharjee.
- Reaction mechanism in Organic Chemistry by S. M. Mukerji.
- Undergraduate Organic Chemistry by Jagdamba Singh and L. D. S. Yadav.
- Organic Chemistry by G. Marc. Loudon.
- Atkin's Physical Chemistry: International by P. W. Atkins.
- Physical Chemistry by D. W. Ball.
- Principles of Physical Chemistry by B. R. Puri, M. S. Pathania and L. R. Sharma.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli.
- Text Book for B. Sc. Chemistry I by A. Bariyar, R. P. Singh and A. Dwivedi.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

<table>
<tr><th colspan="4">UNDERGRADUATE DIPLOMA IN CHEMISTRY</th></tr>
<tr><td colspan="2">Programme: Undergraduate Diploma in Chemistry</td><td>Year: II</td><td>Semester: III
Paper: DSC</td></tr>
<tr><td colspan="4">Subject: Chemistry</td></tr>
<tr><td>Course: DSC (Practical)</td><td colspan="3">Course Title: Chemical Analysis-III</td></tr>
<tr><td colspan="4">Course Outcomes:

After studying this course, the students will be able to:
• To test the inorganic salts for the presence of acidic and basic radicals from IIA and IIB groups.
• Understand the systematic identification of the organic compounds belonging to alcohols and phenols.
• Determine the critical solution temperature of partially miscible liquids.</td></tr>
<tr><td colspan="4">Chemical Analysis-III</td></tr>
<tr><td colspan="2">Credits:1</td><td colspan="2">Discipline Specific Course</td></tr>
<tr><td colspan="2">Max.Marks: As per University rules</td><td colspan="2">Min.Passing Marks: As per University rules</td></tr>
<tr><th>Unit</th><th colspan="2">Topic</th><th>No. of Hours</th></tr>
<tr><td>Unit I</td><td colspan="2">Laboratory hazards and safety precautions</td><td>04</td></tr>
</table>

Unit II	**Inorganic exercise:** Inorganic salt analysis including acidic (all) and basic radicals from II A and IIB group.	**08**
Unit III	**Organic exercise:** Systematic analysis and identification of organic compounds: Alcohols and Phenols/ Stability of carbocation based on reaction of primary, secondary, tertiary alcohol with Lucas reagent	**10**
Unit IV	**Physical exercise:** Determination of critical solution temperature (CST)/ Experiment based on thermodynamic and Chemical equllibrium.	**08**

Note: Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

Recommended Reading

- Vogel's Quantitative Chemical Analysisby J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
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- Analytical Chemistry: Methods of separation by R. V. Ditts.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

SuggestedequivalentonlineContent:

https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

Semester-III

Undergraduate Diploma in Chemistry

DISCIPLINE SPECIFIC ELECTIVE (DSE 3)
Chemistry of Environment

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (ifany)
		Lecture	Tutorial	Practical/Practice		
DSE: Chemistry of Environment	4	4	-	-	Passed Class XII with Chemistry	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: III Paper: DSE 3**
Subject: Chemistry		
Course: DSE	**Course Title: Chemistry of Environment**	

Course Outcomes:

- State Atmosphere, Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere.
- Understand natural resources and management, Coal, Petroleum, natural gas, nuclear fission and fusion, solar energy and wind energy.
- Define environment pollution, diseases caused by environmental factor, type of pollution.
- Understand gulf wars in environment, earth summits, environmental policies and laws (India).

Credits: 4	**Discipline Specific Elective**
Max. Marks: As per University rules	**Min.Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Environment** Concept of environmental chemistry, Our planet Earth, Environment, Composition or structure of the atmosphere (Troposphere, Stratosphere, Mesosphere, Ionosphere or thermosphere, Exosphere. Vertical temperature and vertical structure of the atmosphere. Heat budget of earth atmospheric system.	**10**
Unit II	**Natural Resources and Management** Mineral Resources: Metals and Non-metals, wood, Energy Resources (Coal, Petroleum and Natural Gas, Nuclear Fission and Nuclear Fusion, Solar Energy, Hydrogen, Gasohol), World Energy Resources-Consumption and Conservation, Environmental Management.	**15**

Unit III	**Environment pollution** Pollution, Pollutant, Diseases caused by environmental factors, Biodegradable pollutants, non-biodegradable pollutants, Types of pollution, Thermodynamics, petroleum and pollution.	**10**
Unit IV	**The state of the Global Environment** State of Global Environment, The Gulf Wars and Environment, The Earth Summits, Human Development and Environmental Clean-up Budget, Myths and Ground Realities (Indian Context), Environmental Policies and Laws (India).	**10**
Unit V	**Problems based on the above syllabus**	**15**

Recommended Readings

- Textbook of Biochemistry with Clinical Correlation by T. M. Devlin.
- Biochemistry by J. M. Berg, J. L. Tymoczko and L. Stryer.
- Fundamentals of Biochemistry by U. Satyanarayana and U. Chakrapani.
- Principles of Biochemistry by A. L. Lehninger, D. L. Nelson andM. M. Cox.
- Harper's Illustrated Biochemistry by R. K. Murray, D. K. Granner and P. A. Mayes and V. W. Rodwell.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance ofother activities which can include short exams, in-class room tests, home assignments, group discussions or oral presentations

Semester-III

Undergraduate Diploma in Chemistry

GENERIC ELECTIVE (GE 3)
Basics of Chemistry-III

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteofthe Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Basics of Chemistry-III	4	4	-	-	Passed Class XII	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: III** **Paper:GE 3**
Subject: Chemistry		

Course:GE	CourseTitle: Basics of Chemistry-III

Course Outcomes:

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

- Explain various laws of chemical combination; appreciate the significance of atomicmass, average atomic mass, molecularmass and molecular formula.
- Describe that terms mole and molar mass, mass percent of component element constituting a compound, perform stoichiometric calculation.
- Name the compound according to the IUPAC system of nomenclature and also derive their structure from the given names; write the chemical reactions.
- Understand the laws governing ideal gas, kinetic molecular theory of gases
- Able to distinguish between solid, liquid, and gas in terms of kinetic theory.
- Define various physical constants.

Credits:4	Generic Elective
Max.Marks: As per University rules	Min. Passing Marks: As per University rules

Unit	Topic	No. of Hours
Unit I	**Basic Concepts of Chemistry Lawsof Chemical Combinations**: Law of Conservation, Law of Mass, Law of Definite Proportions, Law of Multiple Proportions, Gay Lussac's Law of Gaseous Volumes, Avogadro's Law, and Dalton's Atomic Theory. **Atomic and Molecular Masses-** Atomic and molecular Mass, Average Atomic Mass, Formula Mass **Stoichiometry and Stoichiometric Calculations**: Limiting Reagent, Reactions in Solutions, simple numericals on stoichiometry.	15
Unit II	**Chemical Bonding and Molecular Structure** Kössel-Lewis Approach: Octet rule taking the example of elements with Z=18, Lewis symbols of elements up to Z=20. Electronic Configurations of Elements and the Periodic Table upto Z=20 **Bonding:** Ionic or Electrovalent Bond: Meaning, formation of NaCl, CaO, $BaCl_2$, types of ions with examples. Covalent Bond: Meaning, formation of HCl, CH_4, CO_2, NH_3, types of covalent bond with examples. **Nomenclature of Organic Compounds**: The IUPAC System of Nomenclature, IUPAC Nomenclature of Straight chain hydrocarbons, Branched chain, Unbranched Saturated hydrocarbons, Substituted Benzene Compounds.	20
Unit III	**Chemical Equation and Reaction** Chemical equations, types of chemical equations, Thermo chemical equation: endothermic and exothermic reaction	10
Unit IV	**Gaseous State** 1. The Gaseous State: experiment on the gaseous state: Boyle, Charles and Avogadro's laws, Ideal Gas Equation 2. Kinetic Molecular Theory of Gases: Postulates and Explanation Difference between solid, liquid, and gas in terms of Kinetic theory. **Physical Constants:** Meltingpoints, meltingpointtheory, mixturemeltingpoint,	15

	packing of melting point tube, Determination of melting point; decomposition, discoloration, softening, shrinking and sublimation. Boiling point, determination of boiling point, use of boiling chips, calibration of thermometer.	

Recommended Readings

- Physical chemistry byPuri, Sharma, Pathania.
- Basic Inorganic Chemistry by Ajai Kumar.
- Concise Inorganic Chemistryby J. D. Lee.
- Concepts and Models in Inorganic Chemistry by B. E. Douglas, D. H. McDaniel andJ. J. Alexander.
- Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharmaand K. C. Kalia.
- Chemistry for Degree Students, B. Sc. First Year by R. L. Madan.
- Selected topics in Inorganic Chemistry by R. D. Madan, U. M. Malik and G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.
- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basu and R. D. Madan.

Suggested Continuous Evaluation Methods: Studentscanbeevaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include shortexams, in-classroom, on-linetests, home assignments, group discussions or oral presentations.

Suggested equivalentonline Content:

https://onlinecourses.nptel.ac.in/noc22_cy36/preview

https://onlinecourses.swayam2.ac.in/cec20_lb01/preview

https://www.youtube.com/watch?v=ZeV3V0DjupQ&list=PLmxSS9XYst20arjxnrIpnL0P99AnswmSs

https://www.youtube.com/watch?v=zGk6VeTfpuE&list=PLmxSS9XYst21tCVcVKQ9n ZdW3OO-

https://www.youtube.com/watch?v=zUwbVaBaxTY&list=PLmxSS9XYst22fU5l0ryKC EZNxuVkia6-

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm

https://www.youtube.com/watch?v=_AYD7YJqQ0Q&t=23s

https://www.youtube.com/watch?v=0LaLl1wskEg

Semester-IV

Undergraduate Diploma in Chemistry

DISCIPLINE SPECIFIC COURSE (DSC 4)
General Chemistry- II
Chemical analysis- IV

No. of Hours-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITESOF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteof thecourse (if any)
		Lecture	Tutorial	Practical/Practice		
DSC 4: General Chemistry-II (Theory) Chemical Analysis-IV (Practical)	4	3	-	1	Passed B.Sc. III Sem with Chemistry (DSC 4)	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: IV** **Paper: DSC 4**
Subject: Chemistry		
Course: DSC (Theory)	**CourseTitle: General Chemistry- II**	

Course Outcomes:

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

- Define the acids and bases on the basis of various concepts/ theories.
- Identify the position of Inner transition elements in the periodic table and able to explain their properties on the basis of their position.
- Knowledge of synthesis of aldehydes, ketones, carboxylic acids and functional groups inter conversion.
- Describe the concepts of electrochemistry in detail and its applications. Also, they will be able to solve the numerical problems based on these concepts.

Credits:4	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Acids and Bases:** Arrhenius concept, Bronsted-Lowry concept, Lux-Flood and Lewis concept of acids and bases; Hard and Soft Acid-Base Theory: Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and	8

	softness.	
Unit II	**Chemistry of Inner Transition Elements:** **Chemistry of Lanthanides:** Electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction and its consequences, complex formation, colour; Methods of separation of lanthanides- fractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods. **Chemistry of Actinides:** General features of actinides-electronic configuration, atomic & ionic radii, ionization potential, oxidation states and complex formation.	**10**
Unit III	**Aldehydes and Ketones:** General methods of preparation and their chemical properties. Rossenmund reaction, Stephen's reduction, Etard reaction, Gattermann Koch reaction, Mechanism of nucleophilic additions to carbonyl group with particular emphasis on aldol, Perkin and Knoevenagel condensation, Oxidation of aldehydes, Cannizzaro reaction, Clemmensen reduction. **Carboxylic Acids:** General methods of preparation Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction. Reduction of carboxylic acids, mechanism of decarboxylation. Dicarboxylic acids-methods of preparation and effect of heat and dehydrating agents	**12**
Unit IV	**Electrochemistry I:** Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations, Numerical Problems. **Electrochemistry II:** Oxidation state, types of redox reactions, Meaning of electrode (Half-cell), Electrode reactions, standard hydrogen electrode-reference electrode, determination of standard electrode potential, determination of p^H and pKa from hydrogen standard electrode, sign conventions, electrochemical series and its significance. Galvaniccells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Derivation of Nernst equation for electrode potential of half-cell and for EMF of cell. Numerical Problems.	**15**

Recommended Readings

- Concise Inorganic Chemistry by J. D. Lee.
- Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K. C. Kalia.
- Chemistry for Degree Students, B. Sc. Second Year by R. L. Madan.
- Selected topics in Inorganic Chemistry by R. D. Madan, U. M. Malikand G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.

- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basuand R. D. Madan.
- Organic Chemistry by I. L. Finar.
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- Organic Chemistry by Boyd, Morrison and Bhattacharjee.
- Reaction mechanism in Organic Chemistry by S. M. Mukerji.
- Undergraduate Organic Chemistry by Jagdamba Singh and L. D. S. Yadav.
- Organic Chemistry by G. Marc. Loudon.
- Atkin's Physical Chemistry: International by P. W. Atkins.
- Physical Chemistry by D. W. Ball.
- Principles of Physical Chemistry by B. R. Puri, M. S. Pathania and L. R. Sharma.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli.
- Text Book for B. Sc. Chemistry I by A. Bariyar, R. P. Singh and A. Dwivedi.

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Suggested equivalent online content:

https://www.youtube.com/watch?v=UJgzQ5XP8wQ&list=PLmxSS9XYst20FfphDeS03pqkcuJk0vuvv
https://www.youtube.com/watch?v=2G79lCT5Os8&list=PLmxSS9XYst23WTFnTWuRg-Ww0k6foth7e
https://www.youtube.com/watch?v=SNXFYz31iFI&list=PLmUlqVgZsTVUfjMBLDQvNLUbF9CIrEsef
https://www.youtube.com/watch?v=1t0GDMSzZ9A&list=PLmxSS9XYst21dec_6u2yWWj295Y8pHGrA

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: IV** **Paper: DSC**
Subject: Chemistry		
Course: DSC (Practical)	**CourseTitle: Chemical Analysis-IV**	

Course Outcomes:

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

- Analyze inorganic salts for the presence of acidic radicals including interfering radicals along with basic radicals from III and IV groups
- Qualitatively differentiate between aldehydes, ketones and carboxylic acids Determine the solubility of salts

Chemical Analysis-IV	
Credits:1	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	**Topic**	**No. of Hours**
Unit I	Laboratory hazards and safety precautions	**4**
Unit II	**Inorganic exercise:** Inorganic salt analysis including acidic/ Interfering radicals and basic	**8**

	radicals from III and IV groups.	
Unit III	**Organic exercise:** Systematic analysis and identification of aldehydes, ketones and carboxylic acids**.** Differentiation between aldehyde and ketones.	**10**
Unit IV	**Physical exercise:** Determination of solubility of salts./ Experiment based on Electrochemistry	**8**

Note: Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 20; Organic exercise 20; Physical exercise 20; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance; 10).

Recommended Readings

- Vogel's Quantitative Chemical Analysisby J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
- Laboratory Handbook of Chromatographic & Allied Methods by O. Mikes andR. A. Chalmes.
- Analytical Chemistry: Methods of separation by R. V. Ditts.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Suggestedequivalentonline content:

https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

Semester-IV

Undergraduate Diploma in Chemistry

DISCIPLINE SPECIFIC ELECTIVE (DSE 4)
Chemistry of Biomolecules

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	CreditdistributionoftheCourse			Eligibility criteria	Pre-requisiteofthe course(if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Chemistry of Biomolecules	4	4	-	-	Passed Class XII with Chemistry	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: IV Paper: DSE 4**
Subject: Chemistry		
Course: DSE 4	**CourseTitle: Chemistry of Biomolecules**	

Course Outcomes:

- Understand the importance of bio molecules in our biological system.
- Gain knowledge about theirnatural sources and diseases caused by the vitamin and mineral deficiencies.

General Organic Chemistry

Credits:4	**Discipline Specific Elective**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Amino acids:** Classification, Pk value, Zwitter ion, isoelectric point, Configuration of amino acids.	10
Unit II	**Vitamins and Minerals**: Types of vitamins and their sources and functions; Minerals and their sources and functions, Vitamin and mineral deficiencies	10
Unit III	**Carbohydrates:** Classification, and general properties, glucose and fructose (open chain and cyclic structure), determination of configuration of monosaccharides, absolute configuration of glucose and fructose, mutarotation.	15
Unit IV	**Lipids:** Classification, Biological importance of triglycerides and phosphor glycerides and cholesterol; Liposomes and their biological functions and underlying applications.	10
Unit V	Problems based on above topics	15

Recommended Readings

- Textbook of Biochemistry with Clinical Correlation by T. M. Devlin.
- Biochemistry by J. M. Berg, J. L. Tymoczko and L. Stryer.
- Fundamentals of Biochemistry by U. Satyanarayana, U. Chakrapaniand.
- Principles of Biochemistry by A. L. Lehninger, D. L. Nelson, M. M. Cox.
- Harper's Illustrated Biochemistry by R. K. Murray, D. K. Granner, P. A. Mayes, V. W. Rodwell.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in class or on-line tests, home assignment, group discussions or oral presentations.

Semester-IV

Undergraduate Diploma in Chemistry

GENERIC ELECTIVE (GE 4)
Basics of Chemistry-IV

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

CourseTitle	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of thecourse (ifany)
		Lecture	Tutorial	Practical/Practice		
GE 4: Basics of Chemistry-IV	4	4	-	-	Passed Class XII	Nil

UNDERGRADUATE DIPLOMA IN CHEMISTRY		
Programme: Undergraduate Diploma in Chemistry	**Year: II**	**Semester: IV** **Paper:GE 4**
Subject: Chemistry		
Course:GE	**CourseTitle: Basics of Chemistry-IV**	

Course Outcomes:
After studying this course, thestudents will be able to:

- Understand the basic concepts of electronegativity and polarization of covalent bond and its significance
- Explain the types of solutions and their uses in daily life.
- Understand different phenomena based on chemistry in the chemical world.

- Define crystallography and types of distillation.
- Understand the concept of isomerism and stereochemistry in chemical compounds.

Credits:4		**Generic Elective 4**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**	
Unit	**Topic**	**No. of Hours**
Unit I	**Electronegativity and polarization of covalent bond;** Inductive, mesomeric, electromeric effect, Resonance, dipole dipole bonding, vander waal bonding, Hydrogenbondinganditssignificance **Isomerismin Co-ordination Compound** Concept of isomerism, Types of isomerism: Structural Isomerism and its type, Stereoisomerism	**10**
Unit II	**Liquid States:** Differences between solids, liquids and gases. Liquid State-Intermolecular forces, Physical properties of liquids including their methods of determination: surface tension, viscosity, Numerical problems. **Solution Chemistry** Solutions, characteristics of solutions, solute and solvent, saturated, unsaturated and super saturated solutions, effect of temperature on solution, neutral, acidic and alkaline solutions, Solubility, suspensions, colloidal solutions.	**15**
Unit III	**Crystallization:** definition evaporative and cooling crytallization**,** Types of crytals. **Distillation:** Simple distillation, distillation theory, fractional distillation, difference between simple and fractional distillation. Reduced pressure distillation.	**15**
Unit IV	**Applied Chemistry**: Chemistry around us as drugs, dyes, polymers, medicines, hormones, Food, beverages, colour, fragrances, Chemicals, fertilizers, paint, cosmetics, alloys. **Understanding Our Chemical World** **a. Explanation of the following observations/ phenomenon with the help of the concepts learned** 1. Why does the mercury in a barometer go up when the air pressure increases? (Gaseous Laws) 2. Why does a hot-air balloon float? (Relation between pressure and temperature) 3. Why is it unwise to incinerate an empty can of air freshener? (Relation between pressure and temperature) 4. Why does petrol evaporate faster than water at the same temperature? (Intermolecular interactions) 5. Why chlorine gas lethal is yet sodium chloride is vital for life? (Chemical bonding, ion) 6. What is the reason for the fizzing of cold drinks? (Solubility and pressure) 7. What is the state of matter in a hot star like the sun? (States of matter) 8. Alcohol (ethanol) is miscible with water but petrol is immiscible. Why? Intermolecular interactions)	**20**

	9. The elements of group 18 in the modern periodic table are called as noble gases. Why? (Periodic Table) 10. If we take 10 g of hydrogen and make it react with 50g of oxygen to form water, part of the hydrogen remains unreacted whereas the whole oxygen is consumed. Why? (Stoichiometry). **b. Explanation of the following observation/ phenomena with the help of chemical reactions involved:** 1. The photochromatic glasses become dark in the sun and light in the dark. 2. Fizzing of Eno (A common antacid) on adding water. 3. Use of baking powder to make the bread fluffy. 4. Burning of matchstick with a pungent smell. Bleaching action of bleaching powder.	

Recommended Readings

- Physical chemistry byPuri, Sharma, Pathania.
- Basic Inorganic Chemistryby Ajai Kumar.
- Concise Inorganic Chemistry by J. D. Lee
- Basic Inorganic Chemistryby Cotton, Wilkinson and Gaus.
- Concepts and Models in Inorganic ChemistryDouglas, McDaniel and Alexander.
- Inorganic Chemistry: Principles of Inorganic chemistry by Huheey, Keiter, Keiter, and Medhi.
- Understanding our Chemical Worldby Paul Monk**.**
- Physical Chemistry byG. M. Barrow.
- Physical Chemistry by G W. Castellan.

Suggested Continuous Evaluation Methods:

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in class or on-line tests, home assignment, group discussions or oral presentations.

Suggested equivalent online content:

https://chem.washington.edu/lecture-demos/match-head-reaction

https://ncert.nic.in/textbook/pdf

https://onlinecourses.nptel.ac.in/noc22_cy36/preview

https://onlinecourses.swayam2.ac.in/cec20_lb01/preview

https://www.youtube.com/watch?v=ZeV3V0DjupQ&list=PLmxSS9XYst20arjxnrIpnL0P99Answm

https://www.youtube.com/watch?v=zGk6VeTfpuE&list=PLmxSS9XYst21tCVcVKQ9nZdW3O20i

://www.youtube.com/watch?v=zUwbVaBaxTY&list=PLmxSS9XYst22fU5l0ryKCEZNxuVkia6-v.

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm

Semester-V

Bachelor of Chemistry

DISCIPLINE SPECIFIC COURSE (DSC 5)
Inorganic & Organic Chemistry
Chemical Analysis- V

No. of Hours- 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Inorganic & organic Chemistry	4	3	-	1	Passed B.Sc. IV Sem with Chemistry (DSC)	Nil

Bachelor of Chemistry		
Programme: Bachelor of Chemistry	**Year: III**	**Semester: V** **Paper: DSC 5**
Subject: Chemistry		
Course: DSC 5 (Theory)	**CourseTitle: Inorganic & Organic Chemistry**	

Course Outcomes:

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

- Describe bonding, EAN and 18-electron rule of metal carbonyls and metal nitrosyls.
- Learn about organometallic compounds, some industrially important inorganic materials and their applications in various industries.
- Understand the various regants utilized in organic synthesis.
- Describe crystal field theory, electronic spectra, magnetic properties and stability of coordination compounds.
- Describes selection rules and, Orgel diagrams for explaining possible electronic transitions and colour of complexes.
- Have a broader idea about the nitrogen containing organic compounds.
- Understand about the carbohydrates and proteins.

Credits: 3	**Discipline Specific Course**
Max.Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Organometallic chemistry:** Metal carbonyls and metal nitrosyls. Nature of bonding, structure and preparation. EAN and 18-electron rule. Definition, nomenclature, classification, general methods of preparation of organometallic compounds and a brief account of metal-ethylenic complexes. Applications of organometallic compounds. **Reagents in Organic Synthesis:** Reagent compounds, types of reagents, NBS, n-butyl lithium, chromium trioxide, $LiAlH_4$, OsO_4, sodium borohydride ($NaBH_4$).	**10**
Unit II	**Electronic Spectra of Transition Metal Complexes:** Types of electronic transitions, selection rules for d-d transitions, calculations of spectroscopic ground states (Russell Saunders/L-S coupling), Orgel energy level diagram for d^1, d^4 and d^6, d^9 tetrahedral and octahedral complexes, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.	**10**
Unit III	**Magnetic Properties of Transition Metal Complexes:** Origin of magnetic behavior, concept of magnetic susceptibility, diamagnetism, paramagnetism, ferromagnetism, ferrimagnetism and antiferromagnetism, magnetic moments, quenching of orbital magnetic moment by crystal field, magnetic susceptibility- definition relationship with temperature, Curie law and Curie Weiss law.	**10**
Unit IV	**Nitrogen Containing Organic Compounds:** **Nitro compounds:** Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. **Amines:** Physical properties, Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), Gabriel-phthalimide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines. Synthetic transformations of aryl diazonium salts, azo coupling. **Carbohydrates and Proteins:** **Carbohydrates:** Classification, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Cyclic structure of D (+)-glucose. Mechanism of mutarotation. **Proteins**: Classification. Structure, Properties and stereochemistry of amino acids. Acid-base behavior, Zwitter ions, isoelectric point and electrophoresis, General introduction of peptides.	**15**

Recommended Readings

- Concise Inorganic Chemistry by J. D. Lee.
- Principles of Inorganic Chemistry by B. R. Puri, L. R. Sharma and K. C. Kalia.
- Chemistry for Degree Students, B. Sc. Second Year by R. L. Madan.
- Selected topics in Inorganic Chemistry by R. D. Madan, U. M. Malikand G. D. Tuli.
- Comprehensive Inorganic Chemistry by S. Chandra.
- Advanced Inorganic Chemistry by S. Prakash, G. D. Tuli, S. K. Basuand R. D. Madan.
- Organic Chemistry by I. L. Finar.
- Stereochemistry of Organic Compounds by E. L. Eliel and S. H. Wilen.
- Organic Chemistry by Boyd, Morrison and Bhattacharjee.
- Reaction mechanism in Organic Chemistry by S. M. Mukerji.
- Undergraduate Organic Chemistry by Jagdamba Singh and L. D. S. Yadav.
- Organic Chemistry by G. Marc. Loudon.
- Atkin's Physical Chemistry: International by P. W. Atkins.
- Physical Chemistry by D. W. Ball.
- Principles of Physical Chemistry by B. R. Puri, M. S. Pathania and L. R. Sharma.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahl and G. D. Tuli.
- Text Book for B. Sc. Chemistry I by A. Bariyar, R. P. Singh and A. Dwivedi.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include shortexams, in class or on-line tests, home assignment, group discussions or oral presentations.

Suggested equivalent online content:

https://www.youtube.com/watch?v=0BQ38GEYF7s&list=PLmxSS9XYst22OYcJbKWq66APcEq5pVsL1
https://www.youtube.com/watch?v=9oQcm281TT0&list=PLmxSS9XYst20MhuKSMREzLhG4ZBIdNys9
https://www.youtube.com/watch?v=WGd4gOncw9s&list=PLmxSS9XYst22CtJwFrXW_VA9kCp7OP0kn
https://www.youtube.com/watch?v=R4rPlpWT1cA&list=PLmxSS9XYst21uxf3tsohnDUmTRFrvfVv8
https://www.youtube.com/watch?v=3TWLAJuVN0c&list=PLmxSS9XYst23hk5m9-MsHTpbADe1Mx-p8
https://www.youtube.com/watch?v=0k4ryWpwhmo&list=PLmxSS9XYst22xP0d02UtcIlgt0GIofvVm
https://www.youtube.com/watch?v=0ZBMRjyHWfY&list=PLmxSS9XYst205pTMkWPmDa3lv0s6DFoXM
https://www.youtube.com/watch?v=najS_fXL38U&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=6
https://www.youtube.com/watch?v=3VoKRgPj7OI&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=8
https://www.youtube.com/watch?v=57hQHf1E3PE&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=7

UNDERGRADUATE DEGREE IN CHEMISTRY		
Programme: Undergraduate Degree in Chemistry	**Year: III**	**Semester: V** **Paper: DSC**
Subject: Chemistry		
Course: DSC (Practical)	**CourseTitle: Chemical Analysis-V**	

Course Outcomes:

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

- Knowledge and skills to understand the inorganic synthesis.
- Analyze the inorganic salts containing acidic radicals and basic radicals form V and VI groups.
- Separate the binary organic mixture and identify the organic compounds present in it.

Chemical Analysis-V		
Credits:1	**Discipline Specific Course**	
Max. Marks: As per University rules	**Min.Passing Marks: As per University rules**	

Unit	Topic	No. of Hours
Unit I	Laboratory hazards and safety precautions	**04**
Unit II	**i. Inorganic synthesis:** Cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetraamminecopper (II) sulphate and hexaamminenickel (II) chloride. Crystallization of compounds.	**08**
	ii. Inorganic salt analysis: Allacidic radicals and basic radicals from V and VI groups.	**06**
Unit III	**i. Organic qualitative analysis:** Separation and identification of organic mixture by water	**08**
	ii. Organic synthesis: Through nitration, halogenation, acetylation, sulphonation and simple oxidation	**04**

Note: Allocation of marks - External assessment: Total marks 75 (Inorganic exercise 30; Organic exercise 30; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

Recommended Readings

- Vogel's Quantitative Chemical Analysisby J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
- Laboratory Handbook of Chromatographic & Allied Methods by O. Mikes andR. A. Chalmes.
- Analytical Chemistry: Methods of separation by R. V. Ditts.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Suggested equivalent online content:
https://www.labster.com/chemistry-virtual-labs/
https://www.vlab.co.in/broad-area-chemical-sciences
http://chemcollective.org/vlabs

Semester-V

Bachelor of Chemistry

DISCIPLINE SPECIFIC ELECTIVE (DSE 5)
Analytical Methods in Chemistry

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteofthe Course (ifany)
		Lecture	Tutorial	Practical/Practice		
DSE 5: Analytical methods in Chemistry	4	4	-	-	Passed B.Sc. IV Sem with Chemistry	Nil

Bachelor of Chemistry		
Programme: Bachelor of Chemistry	**Year: III**	**Semester: V** **Paper: DSE 5**
Subject: Chemistry		
Course Code: DSE 5	**Course Title: Analytical methods in Chemistry**	

Course Outcomes:
After studying this course, the students will be able to:

- Understand about the different techniques utilized in solvent extraction.
- To know about the basics of chromatographic technique and optical methods of analysis.
- Understand about the thermal and electroanalytical methods of analysis.
- Define the quantitative and qualitative aspects of analysis.

Credits:4	**Discipline Specific Elective**
Max.Marks: As per University rules	**Min.Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**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.	**10**
Unit II	**Chromatography:** Classification, principle and efficiency of the technique, Mechanism of separation: adsorption, partition & ion-exchange, Development of chromatograms: frontal, elution and displacement methods.	**10**

Unit III	**Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Transmittance. Absorbance and Beer-Lambert law **Basic principles of quantitative analysis**: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers.	**10**
Unit IV	**Thermal methods of analysis:** Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser. **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. **Qualitative and quantitative aspects of analysis**: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression. Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	**15**
Unit V	**Problems based on above topics**	**15**

Recommended Readings

- Physical chemistry by Puri, Sharma, Pathania.
- Advanced Physical Chemistry by D.N. Bajpai.
- Modern Physical Chemistry by Kunduand Jain.
- Nuclear Chemistry by Arnikar.
- Fundamentals of Photochemistry by K.K. Rohtagi and Mukherji.
- Essentials of Molecular Photochemistry by A. Gilbert and J. Baggott.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include shortexams, in class or on-line tests, home assignment, group discussions or oral presentations.

Semester-V

Bachelor of Chemistry

GENERIC ELECTIVE (GE 5)
Basics of Chemistry-V

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Basics of Chemistry -V	4	4	-	-	Passed Class XII	Nil

Bachelor of chemistry		
Programme: Bachelor of Chemistry	**Year: III**	**Semester: V** **Paper:GE 5**
Subject: Chemistry		
Course:GE 5	**CourseTitle: Basics of Chemistry-V**	

Course Outcomes:

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

- Understand the chemistry of sustainable green reactions.
- To understand the chemistry of natural products
- A basic introduction to chromatography and its types
- Have abroad picture of UV- Visible and IR spectroscopy.

Credits:4	**Generic Elective**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
UnitI	**Green Chemistry**: Basic principles of green chemistry. Designing green reagents: green catalyst phase transfer catalysis for greensynthesis choice of starting materials, organic synthesis in solid phase reagents, and versatile ionicliquids as Scherrer method.	**13**
Unit II	**Natural Products:** Introduction, Primary and Secondary metabolites, use of natural products in traditional medicine, potential of natural products, natural products in drug discovery and development. **Chemistry of natural products**: Introduction, occurrence, classification, extraction, isolation, separation, purification	**15**
Unit III	**Chromatography:** An introduction to Chromatography, Principle, instrumentation and applications of gas and liquid chromatography, Partition Chromatography, Adsorption Chromatography, ion, size- exclusion	**14**

	Chromatography. Extraction-distribution law. Principle and application of TLC, paper, and column chromatography	
Unit IV	**Ultra Violet-Visible Spectroscopy:** Introduction, principle, various electronictransitions (185 to 800 nm), Lambert-Beer's Law, effect of solventon electronic transitions, ultraviolet bands for carbonyl compounds. Instrumentation and applications. **Problem based on UV.** **Infra-red Spectroscopy:** Introduction, principle, instrumentation and sample handling. Selectionrules, normal modes of vibration, Characteristic vibrationalfrequencies of various functional groups. **Problem based on IR.**	**18**

Recommended Readings:

- Introductory Chemistry by J. Nivaldo and HoYuAu-Yeung Tro.
- Basic Chemistry by K. C. Timberlake
- Microscale and Macroscale Techniques in theOrganic Laboratory by D. L. Pavia, G. M. Lampmam, G. S. Kriz and R. G. Engel.
- Exploring Chemical Analysis by D. C. Harris.
- Quantitative Chemical Analysis by D. C. Harris
- Fundamental Concepts of Applied Chemistry by Jayshree Ghosh.
- Principlesof Instrumental Analysis by Skoog.
- Organic Chemistry by I. L. Finar.
- Green Chemistry byV. K. Ahluwalia.
- Environmental Chemistry by W. vanLoon and J. Duffy Stephen.
- Environmental Chemistry by A.K. Day.

Suggested Continuous Evaluation Methods:

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Semester-VI

Bachelor of Chemistry

DISCIPLINESPECIFICCOURSE (DSC 6)
Physical & Analytical Chemistry

No. of Hours-75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Physical & Analytical Chemistry (Theory) Chemical Analysis-VI **(Practical)**	**4**	**3**	**-**	**1**	**Passed B.Sc. Sem V with Chemistry (DSC)**	**Nil**

Bachelor of Chemistry		
Programme: Bachelor of Chemistry	**Year: III**	**Semester: VI** **Paper: DSC 6**
Subject: Chemistry		
Course: DSC 6 (Theory)	**CourseTitle: Physical & Analytical Chemistry**	

Course Outcomes:

After studying this course, thestudents will beableto:

- Understand Surface Phenomenone, Freundlich's and Langmuir's adsorption model.
- Help to the students to gain the knowledge of Elementary Quantum Mechanics and Photochemistry.
- Assess the types of errors and the importance of accuracy and precisions.
- Understand various analytical techniques and their importance.
- Understand spectroscopic techniques will assist the students in solving problems based on the same.

Credits:3	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	Topic	No. of Hours
Unit I	**Surface Chemistry:** Definition of surface phenomenon-Adsorption. Chemical and physical adsorption, Factors affecting adsorption. Isotherm and Isobar. Free energy of adsorption. Quantitative treatment of adsorption, Freundlich's and Langmuir'sadsorption model and their applications. Limitation of Langmuir adsorption model.	**10**

Unit II	**Elementary Quantum Mechanics:** Black-body radiation, Plank'sradiation law, photoelectric effect, Bohr's model of hydrogen atom (noderivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function, Numerical Problems.	**10**
Unit III	**Photochemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry, Grothuss-Drapper law, Lambert'slaw, Lambert-Beer'slaw, Stark-Einsteinlaw, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internalconversion, intersystemcrossing), quantum yield, Numerical Problems.	**10**
Unit IV	**Analytical Techniques:** Basic concepts of electro-gravimetric and coulometric analysis. Thermo gravimetric analysis. Voltammetry; principleof polarography Chromatography: Introduction, types, paper and column chromatography **Spectroscopy:** Electromagnetic radiation, Ultraviolet (UV) spectroscopy-absorptionlaws (Beer-Lambert law), molar absorptivity, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. Infra-Red (IR)spectroscopy- molecular vibrations, Hooke's Law, selection rules, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. **Problems based on UV and IR.** **Data Analysis:** Errors, Definition, types of errors, precision, accuracy, absolute, Significant Figures; significant figures in Arithmatics-addition, subtraction, multiplication and division, Mean and Standard deviation, Standard deviation and probability.	**15**

Recommended Readings

- Chemistry for Degree Students by R. L. Madan.
- Atkin's Physical Chemistry: International by P. W. Atkins.
- Principles of Physical Chemistry by Puri, Pathania and Sharma.
- Essential of Physical Chemistry by A. Bahl, B. S. Bahland G.D. Tuli.
- Physical Chemistry by P. Atkinsand J. de Paula.
- Physical Chemistry by W. J. Moore.
- Fundamentals of Photochemistry by K.K. Rohtagi and Mukherji.
- Essentials of Molecular Photochemistry by A. Gilbert and J. Baggott.
- Introduction to Quantum Chemistry by A. K. Chandra.

Suggested Continuous Evaluation Methods:

Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Suggested online content:

https://www.youtube.com/watch?v=CMYg3ElZwDY
https://www.youtube.com/watch?v=01dY_lLWdMA&t=4s
https://onlinecourses.nptel.ac.in/noc20_cy27/preview
https://onlinecourses.nptel.ac.in/noc21_cy20/preview
https://www.classcentral.com/course/swayam-chemistry-i-introduction-to-quantum-chemistry-and-molecular-spectroscopy-3981
https://www.classcentral.com/course/swayam-quantum-chemistry-of-atoms-and-molecules-19982
https://www.classcentral.com/course/swayam-concepts-of-thermodynamics-13015
https://onlinecourses.nptel.ac.in/noc20_me20/preview
https://www.careers360.com/university/indian-institute-of-technology-kharagpur/concepts-of-thermodynamics-certification-course
https://onlinecourses.nptel.ac.in/noc22_cy14/preview
https://onlinecourses.nptel.ac.in/noc20_cy22/preview
https://onlinecourses.nptel.ac.in/noc21_cy45/preview
https://onlinecourses.nptel.ac.in/noc21_ch48/preview

UNDERGRADUATE DEGREE IN CHEMISTRY		
Programme: Undergraduate Degree in Chemistry	**Year: III**	**Semester: VI** **Paper: DSC**
Subject: Chemistry		
Course: DSC (Practical)	**CourseTitle: Chemical Analysis-VI**	

Course Outcomes:

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

- Understanding the laboratory hazards and safety precautions.
- To determine the solubility of organic compound by titration method.
- To know about the heat of neutralization.
- Able to separate organic compounds using paper chromatography.

Chemical Analysis-VI	
Credits:1	**Discipline Specific Course**
Max. Marks: As per University rules	**Min. Passing Marks: As per University rules**

Unit	**Topic**	**No. of Hours**
Unit I	Laboratory hazards and safety precautions	**04**
Unit II	**Physical exercise:** i. Determination of solubility of organic compound (viz. oxalic acid) in water by titration method. Determination of Heat of neutralization.	**12**
Unit III	**Chromatographic technique:** Demonstrative Chromatography- paper chromatography (separation of organic compounds-Amino acids/ dyes)	**14**

Note: Allocation of marks - External assessment: Total marks 75 (Physical exercise 30; Chromatographic technique: 30; Viva 15); Internal assessment: Total marks 25 (Record 15; attendance 10).

Recommended Readings

- Vogel's Quantitative Chemical Analysis by J. Mendham.
- Instrumental Methods of Analysis by H. H. Willard.
- Analytical Chemistry by G. D. Christian.
- Exploring Chemical Analysis by D. C. Harris.
- Basic Concepts of Analytical Chemistry by S. M. Khopkar.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T. A. Nieman.
- Laboratory Handbook of Chromatographic & Allied Methods by O. Mikes and R. A. Chalmes.
- Analytical Chemistry: Methods of separation by R. V. Ditts.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Suggested equivalent online content:

https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

Semester-VI

Bachelor of Chemistry

DISCIPLINE SPECIFIC ELECTIVES (DSE 6)
General Analytical Techniques

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite ofthe Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE 6: General Analytical Chemistry	4	4	-	-	Passed B.Sc. Sem V With Chemistry	Nil
Bachelor of Chemistry						

Programme: Bachelor of Chemistry	Year: III	Semester:VI Paper: DSE 6
Subject: Chemistry		
Course: DSE 6	**CourseTitle: General Analytical Techniques**	

Course Outcomes:

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

- Understand the basic principles of UV-Visible, Mass, IR, Molecular spectroscopic techniques.
- Understanding the applications of these spectroscopic techniques instructure elucidation.

Credits:4	Discipline Specific Elective 6
Max. Marks: As per Univ.rules	Min.Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours
Unit I	**UV-Visible Spectroscopy:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts.	10
Unit II	**Introduction to Mass Spectrometry:** Principle of massspectrometry, the mass spectrum, massspectrometry diagram, Molecular ion, metastable ion, base peak, fragmentation process. Applicationsof mass spectrometry.	10
Unit III	**Infra-Red (IR) absorption spectroscopy:** molecular vibrations, selection rules, intensity and position of IR bands, measurementof IR spectrum, finger printregion, characteristic absorptions of various functional groups andinterpretation of IR spectraofsimpleorganic compounds.	10
Unit IV	**Molecular Spectroscopy:** Introduction: Electromagneticradiation, regions of the spectrum, statement of the Born-Oppenheimer approximation, degrees of freedom Rotational Spectrum: Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, determination of bond length, isotope effect.	15
Unit V	**Problems based on UV, IR & molecular spectroscopy and mass spectrometry.**	15

Recommended Readings

- Fundamentals of Molecular Spectroscopy by C. N. Banwell and E. M. Mccash.
- Introduction to Spectroscopy by D. L. Pavia.
- Biochemistry by T. A. Brown
- Organic Chemistry by I. L Finar.
- Instrumental methods of analysis by H. H. Willard L. L. Jr. Merritt, J. A. Dean and F. A. Jr. Settle.
- Analytical Chemistry by G. D. Christian.
- Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and S. Crouch.

- Elementary Spectroscopy by Y.R. Sharma.

Suggested Continuous Evaluation Methods:

Studentscanbeevaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.

Semester-VI

Bachelor of Chemistry

GENERIC ELECTIVES (GE 6)
Basics of Chemistry-VI

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteofthe Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Basics of Chemistry-VI	4	4	-	-	Passed Class XII	Nil

Bachelor of Chemistry		
Programme: Bachelor of Chemistry	**Year: III**	**Semester: VI** **Paper: GE 6**
Subject: Chemistry		
Course:GE 6	**CourseTitle: Basics of Chemistry-VI**	

Course Outcomes:

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

- Understand the theorybehindnano chemistry and Green Chemistry.
- Regarding the carbohydrates, proteins, and nucleicacids.
- Understand the chemistry behind the syntheticdyes, making of soap and detergents.
- Understand the importance of chemical approach to polymers with respect to synthesis and various polymerization reactions.
- Understandingtheclassificationofoilsandfats

Credits:4	**Generic Elective**
Max. Marks: As per University rules	**Min.Passing Marks: As per University rules**

Unit	Topic	No of Hours
UnitI	**Nanochemistry**: History, definition, and scope of nanomaterials, chemical methods for synthesis of nanomaterialsmethods of characterization, determination of particle size and surface structure. **Green Chemistry**: Basic principles of green chemistry. Designing green reagents: green catalyst phase transfer catalysis for green synthesis choice of starting materials, organic synthesis in solid phase reagents	**15**

Unit II	**Chemistry of carbohydrate**: classification of carbohydrate, reducing and non reducing sugars, General properties of glucose and fructose their open chain structure, epimers and mutarotation, monomersetc. **Protein and nucleic acids:** Introduction, Structure and nomenclature of proteins, classification, uses. Nucleic acid: introduction, constituents of nucleic acid, Ribonucleosides and ribonucleotides(nomenclature). DNA	**15**
Unit III	**Synthetic dyes:** Colour andconstitution classification of dyes**.** Formation, occurrence, uses **Medicinal Chemistry**: Primary knowledge of structure activity relationship, SAR, quantitative structure activity relationship (QSAR), Chemistry of antineoplastic agents and cardiovascular drugs.	**15**
Unit IV	**Fats, Oils and Detergents:** Natural fats, edible and industrial oils of vegetable origin, common fatty acids, Saponificationvalue, iodine value, Soaps, synthetic detergents, alkyl andaryl sulphonates **Polymers:** Polymers and their characteristics, classification of polymer, natural synthetic, crosslinked and network, plastic elastomers, fiber, homopolymers, copolymers, bondingin polymers, primary and secondary bond force of polymer. Polymerization addition or chain–growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, naturalandsynthetic rubbers.	**15**

Recommended Readings:

- Nanochemistry by G.B. Sergeev, K.J. Klabunde.
- Nanotechnology: Importance and Application by M.H. Fulekar.
- Nanotechnologies, Hazards, and Resource efficiency by M. Steinfeldt.
- Nanotechnology: Health and Environmental risk by JoAnneShatkin.
- Handbook of Nano fabrication by GaryWiederrcht.Elsevier, 2010.
- Nano structured conductive polymersbyAliEftekhari.
- Adsorption and diffusion in nano porous material by Rolando M.A. Raque Malherbe.
- Environmental Chemistry by A.K. Day.
- Supramolecular Chemistry by J. W. Steed and J. L. Atwood.
- Crystal Engineering: The Design of Organic Solids by G.R. Desiraju.
- Supramolecular Chemistry by J.M. Lehn.
- Toxicology: The Basic Science of Poisons by Casarettand Doull's.
- An Introduction toToxicology by P.C. Burcham.
- Analytical Chemistry by G.D. Christian.
- Analytical Chemistry: Principles by J.H. Kennedy.
- FundamentalsofMolecularSpectroscopy by C.N. Banwell and E.M. McCash.

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can include short exams, in-class or on-line tests, home assignments, group discussions or oral presentations.