

NATIONAL EDUCATION POLICY-2020

Common Minimum Syllabus for all Uttarakhand State Universities and Colleges for First Three Years of Higher Education

PROPOSED STRUCTURE OF UG - CHEMISTRY SYLLABUS

2021

Curriculum Design Committee, Uttarakhand

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2.	Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University Member
3.	Prof. P. P. Dhyani Vice-Chancellor , Sri Dev Suman Uttarakhand University Member
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Semester-wise Titles of the Papers in B.Sc. Chemistry

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Introductory Chemistry					
1	I		Fundamentals of Chemistry-I	Theory	4
			Chemical Analysis-I	Practical-1	2
	II		Fundamentals of Chemistry-II	Theory	4
			Chemical Analysis-II	Practical-1	2
Diploma in Chemical Science					
2	III		General Chemistry-I	Theory	4
			Analytical Procedures-I	Practical-2	2
	IV		General Chemistry-II	Theory	4
			Analytical Procedures-II	Practical-2	2
Degree in Bachelor of Science					
3	V		Inorganic Chemistry	Theory	4
			Organic Chemistry	Theory	4
			Analytical Procedures -III	Practical-3	2
			Research Project	Project	Qualifying
	VI		Physical Chemistry	Theory	4
			Analytical Chemistry	Theory	4
			Analytical Procedures -IV	Practical-3	2
			Research Project	Project	Qualifying

Purpose of the Program

The Importance of chemistry arises because so many other disciplines draw on certain chemical principles and concepts. The purpose of the undergraduate chemistry program at the university and college level is to prepare our students for all those fields where basic knowledge of chemistry is required including academia for careers as professionals in various industries and research institutions.

Program Outcomes

- PO 1.** Students will have a firm foundation in the fundamentals and applications of chemical and scientific theories including those in analytical, inorganic, organic and physical chemistry.
- PO 2.** Students will be able to design and carry out scientific experiments as well as accurately record and analyze the data of such experiments.
- PO 3.** Students will develop skill in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- PO 4.** Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- PO 5.** Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- PO 6.** Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
- PO 7.** Students will be able to function as a member of an interdisciplinary problem-solving team.

PROGRAM SPECIFIC OUTCOMES (PSOS)	
CERTIFICATE IN INTRODUCTORY CHEMISTRY	
First Year	Certificate in Introductory Chemistry will give the student a basic knowledge of all the fundamental principles of chemistry like atomic structure, molecular polarity, bonding theories of different molecules, resonance concept, hyperconjugation, field effects, periodic properties of more than 111 elements, mechanism of organic reactions, stereochemistry, 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. Student will be able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory. This certificate course is definitely going to prepare the students for various fields of chemistry and will give an insight into all the branches of chemistry. It will enable students to join the diploma course (semester III and IV) in any University or College of Higher education in Uttarakhand
Second Year	DIPLOMA IN CHEMICAL SCIENCE
	Diploma in Chemical Science will provide the theoretical as well as practical knowledge of handling chemicals, apparatus, equipment and instruments. The knowledge about second law of thermodynamics, chemical equilibrium, phase equilibrium, electrochemistry, coordination chemistry, acid-base theories, chemistry of transition elements, halides, alcohols, phenols, aldehydes, ketones and carboxylic acids will enable the students to work as chemists in various industries. The experimental work during the diploma course will enhance the skill of the students regarding chemical and physical tests of inorganic as well as organic compounds along with some physical experiments which will be beneficial to achieve their goals in industrial sectors. It will enable students to join the Bachelor of Science course (semester V and VI) in any University or College of Higher education in Uttarakhand
Third Year	DEGREE IN BACHELOR OF SCIENCE
	Degree in Bachelor of Science programme aims to introduce very important aspects of modern-day course curriculum, namely, chemistry of nitrogen containing compounds, organometallic, lipids, fats, dyes, paints, reagents in organic synthesis, carbohydrates, proteins, biomolecules, data analysis, nano-chemistry, green chemistry, stability of coordination compounds, cement, paint, ceramics, glass, inorganic fertilizers, radioactivity, corrosion, magnetic behaviour of transition metal complexes, surface chemistry, quantum mechanics, solutions, third law of thermodynamics, photochemistry, and spectroscopic techniques. This knowledge will make the students skilled to work in various chemical industries like cement industries, agro product, paint industries, rubber industries, petrochemical industries, food processing industries, fertilizer industries, pollution monitoring and control agencies etc. It will also enable the students to understand the importance of the biomolecules in biological science and related fields. Upon completion of a degree, chemistry students will be able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments. It will help a candidate to succeed at an entry-level position in chemical industry or a chemistry postgraduate program.

Subject: Chemistry							
Year	Semester	Theory Paper	Units	Practical Paper	Units	Research Project	Total Credits of the Year subject
1	I	Fundamentals of Chemistry-I	<ol style="list-style-type: none"> 1. Atomic Structure and Periodic Properties 2. Chemical Bonding-I 3. Mechanism of Organic Reactions 4. Stereochemistry of Organic Compounds 5. States of Matter-I 6. States of Matter-II 	Chemical Analysis-I	<ol style="list-style-type: none"> 1. Laboratory hazards and safety precautions 2. Inorganic exercise (Acidic radicals including combinations and interfering radicals) 3. Organic exercise 4. Physical exercise 	NIL	4+2=6
	II	Fundamentals of Chemistry-II	<ol style="list-style-type: none"> 1. Chemical Bonding-II 2. Salient Features of <i>s</i>- and <i>p</i>-Block Elements 3. Aliphatic Compounds 4. Aromatic Compounds 5. Chemical Kinetics and Catalysis 6. Thermodynamics I 	Chemical Analysis-II	<ol style="list-style-type: none"> 1. Laboratory hazards and safety precautions 2. Inorganic exercise (acid-base titrations) 3. Organic exercise 4. Physical exercise 	NIL	4+2=6
2	III	General Chemistry-I	<ol style="list-style-type: none"> 1. Chemistry of Transition Elements (First, second and third Transition Series) 2. Coordination Chemistry-I 3. Halides 4. Alcohols and Phenols 	Analytical Procedures-I	<ol style="list-style-type: none"> 1. Laboratory hazards and safety precautions 2. Inorganic mixture analysis (including basic radicals) 3. Organic exercise 4. Physical exercise 	NIL	4+2=6

			5. Thermodynamics II 6. Chemical Equilibrium, Phase Equilibrium				
	IV	General Chemistry-II	1. Acids and Bases 2. Chemistry of Inner Transition Elements 3. Aldehydes and Ketones 4. Carboxylic Acids 5. Electrochemistry I 6. Electrochemistry II	Analytical Procedures-II	1. Laboratory hazards and safety precautions 2. Inorganic exercise (Redox titration) 3. Organic exercise 4. Physical exercise	NIL	4+2=6
3	V	Inorganic Chemistry	1. Metal-Ligand Bonding in Transition Metal Complexes 2. Thermodynamic and Kinetic Aspects of Coordination Compounds 3. Electronic Spectra of Transition Metal Complexes 4. Magnetic Properties of Transition Metal Complexes 5. Organometallic Chemistry 6. Some Industrially Important Inorganic Materials	Analytical Procedures -III	1. Laboratory hazards and safety precautions 2. Inorganic exercise (Synthesis) 3. Organic exercise 4. Physical exercise	Research Project (Qualifying)	4+4+2=10
		Organic Chemistry	1. Lipids and Fats 2. Reagents in Organic Synthesis				

			<ol style="list-style-type: none"> 3. Nitrogen containing organic Compounds 4. Organometallic Compounds 5. Dyes and Paints 6. Carbohydrates and Proteins 				
	VI	Physical Chemistry	<ol style="list-style-type: none"> 1. Surface Chemistry 2. Elementary Quantum Mechanics 3. Photochemistry 4. Solutions and Colligative Properties 5. Thermodynamics III 6. Radiochemistry 	Analytical Procedures -IV	<ol style="list-style-type: none"> 1. Laboratory hazards and safety precautions 2. Physical exercise 3. Spectroscopic exercise/ Chromatographic technique 4. Inorganic exercise (Gravimetric) 	Research Project (Qualifying)	4+4+2=10
		Analytical Chemistry	<ol style="list-style-type: none"> 1. General Biochemistry 2. Data Analysis 3. Fundamentals of Nanochemistry 4. Basics of Green Chemistry 5. Analytical Techniques 6. Spectroscopy 				

Subject: Chemistry							
Course	Semester	Paper Title		Prerequisite for Paper	Elective for Major Subject	Hours per Semester	Total Credits of the Year subject
Certificate in Introductory Chemistry	I	Theory-1	Fundamentals of Chemistry-I	Chemistry of 12 th standard	Yes open for all	60	4
		Practical-1	Chemical Analysis-I	Chemistry of 12 th standard	Yes open for all	60	2
	II	Theory-1	Fundamentals of Chemistry-II	Passed Sem-I Theory paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-1	Chemical Analysis-II	Opted Sem-II Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
Diploma in Chemical Science	III	Theory-1	General Chemistry-I	Passed Certificate Course in Introductory Chemistry	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-2	Analytical Procedures-I	Opted Sem-III Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
	IV	Theory-1	General Chemistry-II	Passed Sem-III Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-2	Analytical Procedures-II	Opted Sem-IV Theory Paper-1	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
Degree in Bachelor of Science	V	Theory-1	Inorganic Chemistry	Passed Sem-III and Sem-IV Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Theory-2	Organic Chemistry	Passed Sem-III and Sem-IV Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-3	Analytical Procedures-III	Opted Sem-V Theory Paper-1 & 2.	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
		Research Project				60	Qualifying
	VI	Theory-1	Physical Chemistry	Passed Sem-V Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Theory-2	Analytical Chemistry	Passed Sem-V Theory papers Theory papers	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	4
		Practical-3	Analytical Procedures-IV	Opted Sem-VI Theory Paper-1 & 2	Yes for the students with major Zoo/Bot./Physics/Math/Comp Sci/Forestry/Geo	60	2
		Research Project				60	Qualifying

Pattern of examination theory papers

A. Theory

Each theory paper shall consist two sections A and B.

Section A: *(Short answers type with reasoning); 45 marks, eight questions of seven marks each, any five have to be attempted).*

Section B: *(Long answers type);30 marks, two questions of fifteen marks each. Both the questions are compulsory with internal choice.*

B. Internal assessment

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25. The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.

C. Practical

The laboratory work of the students has to be evaluated periodically. The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 12 marks for each semester shall be conducted during the semester. A minimum of 12 experiments covering all kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students. In each semester practical examination of 38 marks has to be conducted by two examiners (External and internal) having duration of 4 hours for I to IV Semester and 5 hours for V and VI Semester. The total number of students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital.

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
Certificate in Introductory Chemistry					
1	I		Fundamentals of Chemistry-I	Theory	4
			Chemical Analysis-I	Practical	2
1	II		Fundamentals of Chemistry-II	Theory	4
			Chemical Analysis-II	Practical	2

**Semester-I
Paper-I (Theory)**

Course Title: Fundamentals of Chemistry-I

Programme/Class: Certificate in Introductory Chemistry	Year: First	Semester: First
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: Fundamentals of Chemistry-I	

Course outcomes: There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner. This course will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will gain an understanding of;

- ✓ Molecular geometries, physical and chemical properties of the molecules.
- ✓ Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
- ✓ This course gives a broader theoretical picture in multiple stages in an overall chemical reaction.
- ✓ It describes reactive intermediates, transition states and states of all the bonds broken and formed.
- ✓ It enables to understand the reactants, catalyst, stereochemistry and major and minor products of any organic reaction. It describes the types of reactions and the kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined.
- ✓ The chapter stereochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism. The course will also strengthen the knowledge of students regarding complete picture of states of matter that includes gaseous, liquid, solid and colloidal states.

Credits:4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Content	Number of Hours
1	<p>Atomic Structure and Periodic Properties: Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation (no derivation); significance of ψ and ψ^2. Quantum numbers, radial and angular wave functions and probability distribution curves, 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, Slater's rule.</p> <p>The general idea of Modern periodic table, atomic and ionic radii, ionization potential, electron affinity, electronegativity-definition, trends of variation in periodic table and their application in prediction and explaining the chemical behaviour of elements and compounds thereof.</p>	12
2	<p>Chemical Bonding-I: Ionic bond, covalent bond-Valence Bond Theory and its limitations; various types of hybridization and shapes of different inorganic and organic molecules. Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of NH₃, H₂O, H₃O⁺, SF₄, ClF₃, ICl₂⁻, TeF₅⁻ NH₄⁺ and other simple molecules/ions (CO₂, SO₂, SO₃, Cl₂O₇, SO₄²⁻, CO₃²⁻, NO₃⁻, PO₄³⁻) including compounds of xenon.</p> <p>Resonance, hyperconjugation, field effects- inductive, mesomeric, electromeric effect</p>	8
3	<p>Mechanism of Organic Reactions: Types of reagents-electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates- carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).</p>	8
4	<p>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, inversion, retention and racemization. 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</p>	12

	nomenclature.	
5	<p>States of Matter-I: Gaseous State-Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases, relationship between critical constants and van der Waals constants. Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, Numerical problems.</p> <p>Liquid State-Intermolecular forces, Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity, Numerical problems.</p>	12
6	<p>States of Matter-II:</p> <p>Solid State: Introduction to crystalline materials, Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals. Bragg's equation, Numerical problems.</p> <p>Colloidal State: Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.</p>	8

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994, 1st edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.

- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- xvii. Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.

Suggested online links:

1. <https://www.youtube.com/watch?v=ZcV3V0DjupQ&list=PLmxSS9XYst219YI3DjJUP52APmR9bea1Y>
2. https://www.youtube.com/watch?v=q-P79gnqNR8&list=PLmUlqVgZsTVVRvO3R8g-x12EMc5vmcq_c
3. <https://www.youtube.com/watch?v=gahQYHs0c8s>
4. https://www.youtube.com/watch?v=w2He_Q0Mf0c
5. <https://www.youtube.com/watch?v=q1qMFcZVIPk>
6. <https://www.youtube.com/watch?v=nWTgMr6idf0>
7. <https://www.youtube.com/watch?v=JNLJyhqXaTc&t=10s>
8. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
9. https://onlinecourses.nptel.ac.in/noc22_cy36/preview
10. https://onlinecourses.swayam2.ac.in/cec20_lb01/preview

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) & Attendance	10 marks

Course prerequisites: To study this course, a student must have studied the chemistry of class 12th standard.

Suggested equivalent online courses:

Further Suggestions:

Semester-I, Paper-II (Practical)
Course Title: Chemical Analysis -I

Programme/Class: Certificate in Introductory Chemistry	Year: First	Semester: First
Paper-2 Practical Subject: Chemistry		
Course Code:	Course Title: Chemical Analysis-I	

Course outcomes:

Upon completion of this course, the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixture analysis and estimation of surface tension of commercial products. Also, they can understand the absolute configuration of organic molecules with the help of models. The students will be able to

- ✓ Qualitatively estimate anions and cations in samples.
- ✓ Determine the relative surface tension of a given liquid.
- ✓ Find out the absolute configuration of organic molecules.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	Salt mixture analysis: Identification of acid radicals (three to four) including anions in combination and basic radicals upto II Group in the given salt mixture.	18
3	Organic exercise: Determination of absolute configuration of organic molecules using ball and stick models. Students are supposed to sketch the structure of simple organic compounds showing their stereochemistry using Fischer Projection.	18
4	Physical exercise: Determination of relative surface tension of the given liquid using Stalagmometer.	18

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

Evaluation method	Marks
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Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have studied the chemistry of class 12th standard.

Suggested equivalent online courses:

Further Suggestions:

One exercise each from salt mixture analysis (acidic radicals), organic exercise (absolute configuration) and physical exercise (relative surface tension) shall be given in the examination.

Distribution of marks shall be as given below:

1. Inorganic salt analysis (Acidic and Basic radicals)	10
2. Organic exercise	12
3. Physical	11
4. Viva	05
5. Home assignment/internal assessment, lab record and attendance	12

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester lab record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Suggested Readings:

- i. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- ii. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- iii. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- iv. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- v. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

Suggestive digital platforms web links:

1. <http://chemcollective.org/vlabs>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <https://wp.labster.com/chemistry-virtual-labs/>

Semester-II
Paper-I (Theory)
Course Title: Fundamentals of Chemistry-II

Programme/Class: Certificate in Introductory Chemistry	Year: First	Semester: Second
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: Fundamentals of Chemistry-II	

Course outcomes: Upon successful completion of this course, the students will be able to describe the reactions shown by aliphatic and aromatic compounds. They will also be able to understand the bonding in inorganic molecules, salient features of s- and p- block elements, different aspects of chemical kinetics, catalysis and first law of thermodynamics.

Credits: 4	Compulsory	
Max. Marks: 25+75	Min. Passing Marks:.....	
Total Number of Hours = 60		
Units	Content	Number of Hours
1	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 , Li ₂ , Be ₂ , B ₂ , C ₂ , N ₂ , O ₂ , F ₂ , Ne ₂ , CO, NO, HF difference between VB and MO theories. Multicentre bonding in electron deficient molecules. Polarization of covalent molecules, Percentage ionic character from dipole and electronegativity difference. Polarizing power and polarizability; Fajan's rule. Metallic bond- Electron Pool, valence bond and MO theories. Weak interactions-hydrogen bonding in inorganic and organic molecules and van der Waals interactions.	10
2	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) and chemical properties (reactivity towards water, oxygen, air and moisture, hydrogen, halogens, ammonia). Diagonal relationship, catenation, inert pair effect, pπ- pπ, dπ-pπ bond, chemistry of hydrides, halides, oxides and oxyacids of p-block elements. Silicates, Boron nitrogen compounds (borazene and boron nitrides), interhalogen compounds, basic property of iodine.	10

3	<p>Aliphatic Compounds: Chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes. Cycloalkanes-Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-bent or banana bonds.</p> <p>Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO_4, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.</p> <p>Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal- ammonia reduction, oxidation and polymerization.</p>	10
4	<p>Aromatic Compounds: Aromaticity- the Hückel rule, aromatic ions. Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives.</p>	10
5	<p>Chemical Kinetics and Catalysis: Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction- concentration, temperature, pressure, solvent, light, catalyst; hetero and homocatalysis, significance. Inhibitors, poisons and promoters. Concentration dependence of rates of simple reaction, Molecularity, Order of reaction- zero order, first order, second order, pseudo-order, Radioactive decay a first order phenomenon, half-life period, Methods of determination of the order of reaction- differential method, method of integration, method of half-life period and isolation methods, Numerical problems.</p>	10
6	<p>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. Temperature dependence of enthalpy, Kirchoff's equation, Numerical problems.</p>	10

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1st edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.
- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- xvii. Bariyar, A., Singh, R.P. and Dwivedi, A., "Text Book for B. Sc. Chemistry I", Anu Books, 2019.

Suggested online links:

1. https://www.youtube.com/watch?v=Gg4-go6tTiA&list=PLmxSS9XYst208kJs0npO_v_L-AGkHZJIS
2. https://www.youtube.com/watch?v=sz17_NnMPak&t=51s
3. <https://www.youtube.com/channel/UCUxhnr9H2IYKsuRypG0MAfw/videos>
4. https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
5. <https://www.openlearning.com/courses/introduction-to-physical-chemistry/?cl=1>
6. <https://www.careers360.com/university/indian-institute-of-technology-bombay/chemistry-of-main-group-elements-certification-course>
7. https://onlinecourses.swayam2.ac.in/cec20_lb01/preview
8. <https://nptel.ac.in/courses/104/103/104103071/>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have passed Sem-I, Theory paper-1

Suggested equivalent online courses:

Further Suggestions:

Semester-II, Paper-II (Practical)
Course Title: Chemical Analysis -II

Programme/Class: Certificate in Introductory Chemistry	Year: First	Semester: Second
Paper-2 Practical Subject: Chemistry		
Course Code:	Course Title: Chemical Analysis –II	

Course outcomes:

After completing this course, the students will be able to quantitatively find out the amount of acid or base in the samples, to qualitatively differentiate among different classes of organic compounds and to measure the relative viscosity of a given liquid.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	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.	18

3	Organic exercise: Differentiation between alkanes, alkenes and alkynes. Differentiation between aliphatic and aromatic compounds using chemical and physical tests.	18
4	Physical exercise: Determination of relative viscosity of the given liquid using Ostwald viscometer.	18

Suggested Readings:

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- iv. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- v. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- vi. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
- vii. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- viii. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

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

Evaluation method	Marks
Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have opted Semester-II Theory Paper-I

Suggested equivalent online courses:

Further Suggestions:

One exercise each from volumetric analysis (acid-base titration), organic exercise (tests for alkanes, alkenes, alkynes, aliphatic and aromatic compounds) and physical exercise (relative viscosity) shall be given in the examination.

Distribution of marks shall be as given below:

- | | |
|-----------------------|----|
| 1. Inorganic exercise | 12 |
| 2. Organic exercise | 11 |
| 3. Physical | 10 |
| 4. Viva | 05 |

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
Diploma in Chemical Science					
2	III		General Chemistry-I	Theory	4
			Analytical Procedures-I	Practical	2
2	IV		General Chemistry-II	Theory	4
			Analytical Procedures-II	Practical	2

Semester-III
Paper-I (Theory)
Course Title: General Chemistry-I

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Third
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: General Chemistry-II	

Course outcomes: This paper provides detailed knowledge of synthesis of various classes of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.

- ✓ It relates and gives an analytical aptitude for synthesizing various industrially important compounds.
- ✓ This paper also provides a detailed knowledge on the elements present in our surroundings, their occurrence in nature. Their position in periodic table, their physical and chemical properties. This paper also gives detailed understanding of the d-block elements and their characteristics.

- ✓ After successful completion of this course, the students will be able to gather the information regarding Werner's theory and VBT of transition metal complexes.
- ✓ Students will be able to learn the basic concepts of spontaneity, chemical and phase equilibrium and able to apply these concepts in predicting the spontaneous reactions and will be able to solve the numerical problems based on these concepts.

Credit: 4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Hours- = 60	

Unit	Contents	Number of Hours
1	<p>Chemistry of Transition Elements (First, second and third Transition Series): Characteristic properties of the elements; electronic configuration, atomic & ionic radii, oxidation states and stability of uncommon oxidation states, ionization energy, boiling & melting points, complex compound formation, colour, catalytic properties and magnetic properties. coordination number and geometry.</p> <p>Comparative treatment of 3d, 4d and 5d elements and their analogues in respect of occurrence, atomic & ionic radii, oxidation state, ionization energy, complex formation tendency, magnetic behaviour, geometry and colour.</p>	10
2	<p>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, effective atomic number (EAN) concept, 18-electron rule, stability of complexes and factors contributing to the stability. Chelates- Introduction, factors affecting the stability of chelates, thermodynamic origin of stability, applications. Valence Bond Theory (VBT) for coordination compounds, geometry of complexes (tetrahedral, octahedral, square planar), magnetic properties of complex compounds.</p>	10
3	<p>Halides: Chemical reactions. Alkyl, aryl and vinyl halides. Mechanism of nucleophilic substitution reactions, S_N2 and S_N1 reactions with energy profile diagrams.</p>	8
4	<p>Alcohols and Phenols: Alcohols: Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)₄ and HIO₄] and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.</p>	12

	Phenols: Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, Houben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.	
5	Thermodynamics II: Second law of thermodynamics, need of the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. 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. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change 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. Variation of G and A with P, V and T, Gibbs-Helmholtz equation, Numerical problems.	12
6	Chemical Equilibrium: The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between K_p and K_c . Le-Chatelier's principle, Numerical problems. Phase Equilibrium: Statement and meaning of the terms: phase, component and degree of freedom, Gibbs phase rule, phase equilibria of one component systems- water, carbon dioxide and sulphur. Raoult's and Henry's law.	8

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.

- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994, 1st edition.
- ix. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.
- x. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- xi. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- xii. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- xiii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.

Suggested online links:

1. <https://www.youtube.com/watch?v=FmclK9oUkEE&list=PLmxSS9XYst20Pz1SpRI4jdcrv-zh1AoYy>
2. <https://www.youtube.com/watch?v=y67STFWoQ3A&list=PLmUlqVgZsTVV9zQAF-umZzs65MzOU8Ty9>
3. https://www.youtube.com/watch?v=xo2sRayaVyc&list=PLmUlqVgZsTVUAETHwJsJw_WPE87_yfhCO
4. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
5. <https://nptel.ac.in/courses/104/103/104103071/#>
6. <https://swayam.gov.in/>
7. <https://nptel.ac.in/courses/104/103/104103071/>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have passed Certificate Course in Introductory Chemistry.

Suggested equivalent online courses:

Further Suggestions:

Semester-III Paper-II (Practical)
Course Title: Analytical Procedures-I

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Third
Paper-II Practical Subject: Chemistry		
Course Code:	Course Title: Analytical Procedures-I	

Course outcomes:

After completing this course, the students will be able to test the inorganic mixtures of acidic and basic radicals in given samples, to qualitatively differentiate between alcohols and phenols and determine the critical solution temperature of partially miscible liquids.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	Inorganic exercise: Complete analysis of inorganic mixture including both acid and basic radicals with a special emphasis on the role of common ion effect and solubility product.	30
3	Organic exercise: Functional group tests for alcohols and phenols. Differentiation between alcohols and phenols using chemical and physical tests.	12
4	Physical exercise: Determination of critical solution temperature (CST)	12

Suggested Readings:

- i. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- ii. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wordsworth Publishing Company, Belmont, California, USA, 1988.
- iii. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- iv. Harris, D. C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- v. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- vi. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
- vii. Mikes, O. & Chalmes, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- viii. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

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

Evaluation method	Marks
Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have opted Sem-III Theory Paper-1

Suggested equivalent online courses:

Further Suggestions:

One exercise each from Inorganic mixture (qualitative), organic exercise (tests for alcohols and phenols) and physical exercise (critical solution temperature) shall be given in the examination.

Distribution of marks shall be as given below:

- | | |
|---|----|
| 1. Inorganic exercise | 10 |
| 2. Organic exercise | 12 |
| 3. Physical exercise | 11 |
| 4. Viva | 05 |
| 5. Home assignment/internal assessment, lab record and attendance | 12 |

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Semester-IV**Paper-I (Theory)****Course Title: General Chemistry-II**

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Fourth
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Paper-I Theory Subject: Chemistry	
Course Code:	Course Title: General Chemistry-II

Course outcomes: This paper provides detailed knowledge of synthesis of aldehydes, ketones, carboxylic acids and functional groups inter conversion. The students will be able to describe the concepts of electrochemistry in detail and its applications. Also, they will be able to solve the numerical problems based on these concepts. Students will be able to define the acids and bases on the basis of various concepts/ theories and will be able to identify the position of various elements in the periodic table and able to explain their properties on the basis of their position.

Credits: 4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Hours- = 60

Unit	Contents	Number of Hours
1	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 softness; Role of the solvent and strength of acids and bases. Acid-base properties in non-aqueous media.	10
2	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
3	Aldehydes and Ketones: Comparative account of properties of aliphatic and aromatic aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH ₄ and NaBH ₄ reductions. Halogenation of enolizable ketones. An introduction to α -, β -unsaturated aldehydes and ketones.	10
4	Carboxylic Acids: Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides.	10

	Reduction of carboxylic acids, mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids, hydroxy acids- malic, tartaric, and citric acids. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids-methods of preparation and effect of heat and dehydrating agents.	
5	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.	8
6	Electrochemistry II: Oxidation state, types of redox reactions, balancing of chemical reactions by ion electron and oxidation state method. Computations of equivalent weights. Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Calculation of thermodynamic quantities of cell reactions (ΔG , ΔH and K), Numerical Problems.	12

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Second Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
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- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- viii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Willey, 1994, 1st edition.

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- xiv. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- xv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- xvi. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.

Suggested online links:

1. <https://www.youtube.com/watch?v=UJgzQ5XP8wQ&list=PLmxSS9XYst20FfphDeS03pqkcUJk0vuvv>
2. <https://www.youtube.com/watch?v=2G79ICT5Os8&list=PLmxSS9XYst23WTFnTWuRg-Ww0k6foth7e>
3. <https://www.youtube.com/watch?v=SNXFYz31iFI&list=PLmUlqVgZsTVUfjMBLDQvNLUbF9CIReseF>
4. https://www.youtube.com/watch?v=1t0GDMSzZ9A&list=PLmxSS9XYst21dec_6u2yWWj295Y8pHGrA
5. <https://swayam.gov.in/>
6. <https://www.coursera.org/learn/physical-chemistry>
7. <https://www.mooc-list.com/tags/physical-chemistry>
8. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
9. <https://nptel.ac.in/courses/104/103/104103071/>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have had Passed Sem-III Theory Paper-1

Suggested equivalent online courses:

Further Suggestions:

Semester-IV Paper-II (Practical)
Course Title: Analytical Procedures-II

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Fourth
Paper-II Practical Subject: Chemistry		
Course Code:	Course Title: Analytical Procedures-II	

Course outcomes:

After completing this course, the students will be able to determine the concentrations of oxidising and reducing agents through double titration, qualitatively differentiate between aldehydes, ketones and carboxylic acids and determine the solubility of salts.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	Inorganic exercise: Volumetric exercises (double titration) based on redox reactions involving internal as well as external indicators.	18
3	Organic exercise: Preliminary and Functional group tests for aldehydes, ketones and carboxylic acids (both aliphatic and aromatic).	18
4	Physical exercise: Determination of solubility of salts.	18

Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

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

1.

Evaluation method	Marks
Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have Opted Sem-IV Theory Paper-1

Suggested equivalent online courses:

Further Suggestions:

One exercise each from inorganic volumetric analysis (quantitative), organic exercise (tests for aldehydes, ketones and carboxylic acids) and physical exercise (solubility of salts) shall be given in the examination.

Distribution of marks shall be as given below:

1. Inorganic exercise	12
2. Organic exercise	11
3. Physical exercise	10
4. Viva	05
5. Home assignment/internal assessment, lab record and attendance	12

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 04 (four) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
Degree in Bachelor of Science					
3	V		Inorganic Chemistry	Theory	4
			Organic Chemistry	Theory	4
			Analytical Procedures-III	Practical	2
3	VI		Physical Chemistry	Theory	4
			Analytical Chemistry	Theory	4
			Analytical Procedures-IV	Practical	2

Semester-V

Paper-I (Theory)

Course Title: Inorganic Chemistry

Programme/Class: Degree	Year: Third	Semester: Fifth
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in Bachelor of Science	
	Paper-1 Theory Subject: Chemistry
Course Code:	Course Title: Inorganic Chemistry

Course Outcomes: Upon successful completion of this course, the students will be able to describe the stability, crystal field theory, electronic spectra and magnetic properties of coordination compounds. They will also learn about organometallic compounds, some industrially important inorganic materials and their applications in various industries. It will assist them to get a suitable job in the relevant industrial and scientific field.

Credits:4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Metal-Ligand Bonding in Transition Metal Complexes: Limitations of valence bond theory, an elementary idea about crystal field theory (CFT); crystal field splitting of octahedral and tetrahedral complexes, tetragonal distortion (Jahn-Teller distortion, crystal field splitting of square planar and trigonal bipyramidal complexes, factors affecting the crystal-field parameters, calculation of crystal field stabilization energy (CFSE), spectrochemical series. Applications (color and magnetic properties) and limitations CFT. Comparison between VBT and CFT.	10
2	Thermodynamic and Kinetic Aspects of Coordination Compounds: Stability of metal complexes- thermodynamic and kinetic stability, stable and unstable complexes, inert and labile complexes, stepwise and overall stability constants, relationship between the stepwise and overall stability constants, factors affecting the thermodynamic and kinetic stabilities of coordination compounds. Chelate effect and its thermodynamic origin. Determination of binary formation constants by pH-metry and spectrophotometry	10
3	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 $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.	8
4	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. methods of determining magnetic susceptibility;	10

	Gouy's and Quincke's methods, magnetic moment, spin only formula, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.	
5	Organometallic Chemistry: Definition, nomenclature and classification based on nature of metal-carbon bond. 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-Ziegler-Natta catalyst, Wilkinson catalyst (No mechanism).	8
6	Some Industrially Important Inorganic Materials: Silicones, siloxanes, polymethylhydrosiloxanes, their applications. Phosphazenes, nature of bonding in triphosphazenes. Aluminosilicates- Feldspars, Ultramarines, Zeolites. Clays and Pillared Clays. Cement- manufacture, composition and setting. Glass-manufacture, annealing, types and uses. Ceramics-definition, traditional and new ceramics, structure of ceramics. Inorganic fertilizers-essential nutrients for plants, nitrogenous, phosphatic and potash fertilizers.	14

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- iv. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- v. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vi. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.

Suggested online links:

1. <https://www.youtube.com/watch?v=0BQ38GEYF7s&list=PLmxSS9XYst22OYcJbKWq66APcEq5pVsL1>
2. <https://www.youtube.com/watch?v=9oQcm281TT0&list=PLmxSS9XYst20MhuKSMREzLhG4ZBIIdNys9>

3. https://www.youtube.com/watch?v=WGd4gOncw9s&list=PLmxSS9XYst22CtJwFrXW_VA9kCp7OP0kn
4. <https://www.youtube.com/watch?v=R4rPlpWT1cA&list=PLmxSS9XYst21uxf3tsohnDUmTRFrvfVv8>
5. <https://www.youtube.com/watch?v=3TWLAJuVN0c&list=PLmxSS9XYst23hk5m9-MsHTpbADe1Mx-p8>
6. <https://www.youtube.com/watch?v=0k4ryWpwhmo&list=PLmxSS9XYst22xP0d02UtcIlgT0GIofvVm>
7. <https://www.youtube.com/watch?v=0ZBMRjyHWfY&list=PLmxSS9XYst205pTMkWPmDa3lv0s6DFoXM>
8. https://www.youtube.com/watch?v=najS_fXL38U&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=6
9. <https://www.youtube.com/watch?v=3VoKRgPj7OI&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=8>
10. <https://www.youtube.com/watch?v=57hQHf1E3PE&list=PLmxSS9XYst23yE3f2Kqsir4lQ1dTmofFv&index=7>
11. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy19/>
12. https://onlinecourses.nptel.ac.in/noc22_cy02/preview
13. <https://nptel.ac.in/courses/104/105/104105033/>
14. <https://nptel.ac.in/courses/104/101/104101079/>
15. https://onlinecourses.nptel.ac.in/noc21_cy12/preview
16. <https://nptel.ac.in/courses/104/108/104108062/>
17. https://onlinecourses.nptel.ac.in/noc21_cy36/preview
18. https://onlinecourses.nptel.ac.in/noc22_cy05/preview
19. <https://nptel.ac.in/courses/104/105/104105033/>
20. <https://www.york.ac.uk/media/chemistry/research/douthwaite/Metal-Ligand%20bonding%20and%20Inorganic%20reaction%20mechanisms.pdf>
21. <https://nptel.ac.in/courses/104/106/104106089/>
22. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000658/M014009/ET/1456899566CHE_P3_M5_etext.pdf
23. http://ddugu.ac.in/epathshala_content1.aspx
24. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
25. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/07.inorganic_chemistry-ii/31.magnetic_properties_of_transition_metal_ions/et/6388_et_chemistry_p7_m31_etext.pdf
26. <https://egyankosh.ac.in/bitstream/123456789/15794/1/Unit-7.pdf>
27. <https://www.hhrc.ac.in/ePortal/Chemistry/IImsscchem-18pche3-unit1-sv.pdf>
28. <http://www.du.edu.eg/upFilesCenter/sci/1596861612.pdf>
29. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
30. <https://nptel.ac.in/courses/104/105/104105103/>
31. <https://www.uou.ac.in/sites/default/files/slm/BSCCH-301.pdf>
32. <https://nptel.ac.in/content/storage2/courses/103107086/module1/lecture1/lecture1.pdf>
33. <https://nptel.ac.in/content/storage2/courses/103107086/module4/lecture1/lecture1.pdf>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have passed Sem-III and Sem-IV Theory papers.

Suggested equivalent online courses:

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

Further Suggestions:

Semester-V
Paper-II (Theory)
Course Title: Organic Chemistry

Programme/Class: Degree in Bachelor of Science	Year: Third	Semester: Fifth
Paper-II Theory Subject: Chemistry		
Course Code:	Course Title: Organic Chemistry	

Course Outcomes: Upon successful completion of this course, the students should be able to describe the chemistry of nitrogen containing compounds, the basic understanding of the chemistry of industrially important materials such as lipids, fats, soaps, detergents, dyes, paints and reagents in organic synthesis. Upon completion of this course students may get job opportunities in food, soap, detergent, paint and other organic material based synthetic labs and industries. Biomolecules are important for the functioning of living organisms. These molecules perform or trigger important biochemical reactions in living organisms. When studying biomolecules, one can understand the physiological function that regulates the proper growth and development of a human body. This course aims to introduce the students with basic experimental understanding of carbohydrates and proteins.

Credits:4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Lipids and Fats: Lipids-Definition, categories, biological	12

	functions, metabolism, nutrition and health, tests, examples. Fats-Definition, biological importance, metabolism, digestion and it's metabolism. Soaps, Detergents and their action mechanism.	
2	Reagents in Organic Synthesis: Reagent compounds, types of reagents, acetylene, ammonia, Bayer's reagent, NBS, n-butyl lithium, CAN, chromic acid, chromium trioxide, diborane, DMSO, dioxane, Fehling reagent, Grignard reagent, hydrazide, hydrogen peroxide, LAH, OsO ₄ , PCl ₅ , potassium dichromate, potassium permanganate, Raney Ni, silver nitrate, sodium borohydride, NaH, THF, TMS, SOCl ₂ , Tollen's reagent.	12
3	Nitrogen Containing Organic Compounds: Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Picric acid. Halo nitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.	14
4	Organometallic Compounds: Organ magnesium compounds; the Grignard reagent-formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions.	10
5	Dyes and Paints: Color and constitution, types of dyes, Alizarin, Indigo, Congo red, Malachite green, Methylene blue, Phenolphthalein, Methyl orange. Paints and Varnishes: Definition, components, chemistry, applications.	10
6	Carbohydrates and Proteins: Carbohydrates: Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides. Proteins: Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Classification of proteins.	12

Books Recommended:

- i. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- ii. Eliel, E.L. and Wilen, S.H., "Stereochemistry of Organic Compounds", Wiley, 1994, 1st edition.
- iii. Boyd, Morrison and Bhattacharjee, "Organic Chemistry", Pearson Education India, 2010, 7th edition.
- iv. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- v. Singh, Jagdamba and Yadav, L.D.S., "Undergraduate Organic Chemistry" Pragati Prakashan, India, 2011, Vol 1.
- vi. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- vii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- viii. Bahl, A. and Bahl, B.S. a "Advance Organic Chemistry", S. Chand Publishing, India, 2010.

Suggested online links:

1. https://www.youtube.com/watch?v=xBNv80Dg6nI&list=PLmUlqVgZsTVUk5NkroUmYXvbterBXbk_J
2. https://www.youtube.com/watch?v=UgbaIFI_q6E
3. <https://www.youtube.com/watch?v=tz0BrCqPTV0&t=15s>
4. <https://www.youtube.com/watch?v=2sHILNzTpUU&t=4s>
5. <https://www.youtube.com/watch?v=ALaTCbetFSg&t=210s>
6. <https://www.youtube.com/watch?v=kruIzuor5v8>
7. <https://www.youtube.com/watch?v=IuERNLx-J7k&t=19s>
8. <https://www.youtube.com/watch?v=RW7KlYbpNzk&t=1414s>
9. <https://www.youtube.com/watch?v=LcUoeFe0iN8>
10. <https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm>
11. <https://nptel.ac.in/courses/104/103/104103111/>
12. <https://nptel.ac.in/courses/104/103/104103071/>
13. https://onlinecourses.nptel.ac.in/noc19_cy24/preview
14. <https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod10.pdf>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have passed Sem-III and Sem-IV Theory papers.

Further Suggestions:

Semester-V, Paper-III (Practical)

Course Title: Analytical Procedures-III

Programme/Class: Certificate in Introductory/General Chemistry	Year: Third	Semester: Fifth
Paper-III Practical Subject: Chemistry		
Course Code:	Course Title: Analytical Procedures-III	

Course outcomes:

Upon completion of this course, the students will have the knowledge and skills to understand the synthetic methods related to inorganic and organic fields. Also, they can easily analyze the nitrogen containing compounds and separate the binary organic mixture.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	Inorganic exercise: Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetraamminecopper(II) sulphate and hexaamminenickel(II) chloride. Crystallization of compounds.	14
3	Organic exercise: Organic qualitative analysis: Analysis of Nitrogen containing organic compounds (detection of elements, amines, nitro, amides and anilides) Binary mixture of organic compounds separable by water Organic synthesis: through nitration, halogenation, acetylation, sulphonation and simple oxidation	40

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

Evaluation method	Marks
Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have opted Sem-V Theory Paper-1 &2

Suggested equivalent online courses:

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

Further Suggestions:

One exercise each from inorganic synthesis, organic qualitative analysis and organic synthesis shall be given in the examination.

Distribution of marks shall be as given below:

- | | |
|---|----|
| 1. Inorganic exercise | 10 |
| 2. Organic exercise | 23 |
| 3. Viva | 05 |
| 4. Home assignment/internal assessment, lab record and attendance | 12 |

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 05(five) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Semester-VI
Paper-I (Theory)
Course Title: Physical Chemistry

Programme/Class: Degree in Bachelor of Science	Year: Third	Semester: Sixth
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: Physical Chemistry	

Course outcomes: The core concepts of Physical Chemistry have been included in this semester with a view that students' command over these topics will help them to understand the higher chemistry in PG classes. Their understanding of Photochemistry and Solutions will help him to explain the day today phenomenon of the relevant field whereas. Thermodynamics will help them to understand the natural flow of energy. Learning the Quantum Mechanics will help them to praise the beauty of behavior of fundamental particles. It will assist them to get a suitable job in the relevant industrial and scientific field.

Credits:4	Compulsory
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	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's adsorption model and their applications. Limitation of Langmuir adsorption model. Adsorption in catalysis, characteristics of catalyzed reactions.	10
2	Elementary Quantum Mechanics: Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) 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.	12
3	Photochemistry: Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert-Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, Numerical Problems.	10

4	Solutions and Colligative Properties: Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point, Numerical Problems.	10
5	Thermodynamics III: Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data, Numerical Problems	8
6	Radioactivity: Definition, nature of radioactivity, emission, types of radioactivity, occurrence, Energetics and kinetics radioactivity, rates of radioactive transitions, Applications of radioactivity, Numerical Problems.	10

Books Recommended:

- i. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- ii. Atkins P.W., "Atkin's Physical Chemistry: International", Oxford University Press, 2018, 11th edition.
- iii. Ball D.W., "Physical Chemistry", Cengage India Private Limited, 2017, 2nd edition.
- iv. Puri, B.R., Pathania, M.S. and Sharma, L.R., "Principles of Physical Chemistry", Vishal Publishing, India, 2020, 47th edition.
- v. Bahl, A., Bahl, B.S. and Tuli, G.D., "Essential of Physical Chemistry", S. Chand Publishing, India, 2010.
- vi. Atkins, P. and de Paula, J. (2005). Physical Chemistry: 7th edition. Oxford University Press.
- vii. Moore, W.J. (1976). Physical Chemistry: 5th edition. Orient Longman Limited.
- viii. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
- viii. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publication.
- ix. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill

Suggested online links:

1. <https://www.youtube.com/watch?v=CMYg3ElZwDY>
2. https://www.youtube.com/watch?v=01dY_ILWdMA&t=4s
3. https://onlinecourses.nptel.ac.in/noc20_cy27/preview
4. https://onlinecourses.nptel.ac.in/noc21_cy20/preview
5. <https://www.classcentral.com/course/swayam-chemistry-i-introduction-to-quantum-chemistry-and-molecular-spectroscopy-3981>
6. <https://www.classcentral.com/course/swayam-quantum-chemistry-of-atoms-and-molecules-19982>

7. <https://nptel.ac.in/courses/104/108/104108057/>
8. <https://nptel.ac.in/courses/115/101/115101107/>
9. <https://nptel.ac.in/courses/104/101/104101124/>
10. <https://nptel.ac.in/courses/104/105/104105128/>
11. <https://www.classcentral.com/course/swayam-concepts-of-thermodynamics-13015>
12. https://onlinecourses.nptel.ac.in/noc20_me20/preview
13. <https://www.careers360.com/university/indian-institute-of-technology-kharagpur/concepts-of-thermodynamics-certification-course>
14. <https://www.coursera.org/learn/thermodynamics-intro>
15. https://onlinecourses.nptel.ac.in/noc22_cy14/preview
16. https://onlinecourses.nptel.ac.in/noc20_cy22/preview
17. https://onlinecourses.nptel.ac.in/noc21_cy45/preview
18. https://onlinecourses.nptel.ac.in/noc21_ch48/preview

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have passed Sem-V Theory papers.

Suggested equivalent online courses:

Further Suggestions:

Semester-VI
Paper-II (Theory)
Course Title: Analytical Chemistry

Programme/Class: Degree in Bachelor of Science	Year: Third	Semester: Sixth
		Paper-II Theory Subject: Chemistry
Course Code:	Course Title: Analytical Chemistry	

Course outcomes: After completion of this course, the students will be able to understand the chemistry of biomolecules. They will become acquainted in the field of data analysis. The new frontiers of chemistry such as nano-chemistry and green chemistry are the part of syllabi of this course which boost the knowledge of the students in these fields. The chemistry of industrially important inorganic materials such as cement, ceramics, glass and inorganic fertilizers has been incorporated in the course to enhance the skills and capability of the

students pursuing this course. The students will also be able to understand the analytical techniques such as electro-gravimetric analysis, coulometric analysis, thermogravimetry, polarography and chromatography.

- ✓ Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- ✓ Students will be able to function as a member of an interdisciplinary problem solving team.
- ✓ Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- ✓ Students will gain an understanding of how to determine the structure of organic molecules using UV, IR and NMR spectroscopic techniques.

Credits:4	Compulsory
Max. Marks: 25+75	Min. Passing Marks...

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	General Biochemistry: Introduction to biomolecules, Enzymes; Definition, classification, role in physiology. General introduction to hormones. Nucleic acids; Nitrogen bases, purines, pyrimidines, nucleosides, nucleotides, structure of RNA and DNA molecule.	12
2	Data Analysis: Errors; Definition, types of errors, precision, accuracy, absolute, Significant Figures; significant figures in Arithmetics-addition, subtraction, multiplication and division, Mean and Standard deviation, Standard deviation and probability.	10
3	Fundamentals of Nanochemistry: Definition, brief history, classification, general approach of nano synthesis, general methods of characterization, general applications.	9
4	Basics of Green Chemistry: Introduction, role of green chemistry in sustainable development, principles of green chemistry.	8
5	Analytical Techniques: Basic concepts of electro-gravimetric and coulometric analysis. Thermogravimetric analysis. Voltametry; principle of polarography Chromatography: Introduction, Types, paper and column chromatography	9
6	Spectroscopy: Ultraviolet (UV) absorption spectroscopy-absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, 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.	12

	<p>Infra-Red (IR) absorption spectroscopy- molecular vibrations, Hooke's Law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Nuclear magnetic resonance (NMR) spectroscopy; Proton magnetic resonance (^1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of ^1H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and ^1H NMR spectroscopic techniques</p>	
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Books Recommended:

- i. Clark, J. H., and Macquarrie, D.J., Handbook of Green Chemistry and Technology, Wiley-Blackwell, 2002.
- ii. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
- iii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2008, 2nd edition.
- iv. P. H. Raven, Biology, Tata MacGraw Hill.
- v. P. Sheeler, Cell and Molecular Biology, John Wiley.
- vi. N. A. Campbell, Biology Pearson.
- vii. L. Styer, Biochemistry, Freeman & Co.
- viii. Outlines of biochemistry. Fourth edition (Conn, Eric E.; Stumpf, P. K.). Wiley India Pvt. Limited

Suggested online links:

1. <https://www.youtube.com/watch?v=qJMJUtgVUVw>
2. <https://www.youtube.com/watch?v=58pAYgrZjF0&t=26s>
3. https://onlinecourses.nptel.ac.in/noc19_mm21/preview
4. <https://www.classcentral.com/course/swayam-introduction-to-data-analytics-3973>
5. https://onlinecourses.nptel.ac.in/noc21_cy26/preview
6. <https://www.classcentral.com/course/swayam-biochemistry-5229>
7. https://onlinecourses.nptel.ac.in/noc19_cy18/preview

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks

Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	05 marks
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Course prerequisites: To study this course, a student must have passed Sem-V Theory papers.

Suggested equivalent online courses:

Further Suggestions:

Semester-VI, Paper-III (Practical)

Course Title: Analytical Procedures-IV

Programme/Class: Certificate in Introductory/General Chemistry	Year: Third	Semester: Sixth
Paper-III Practical Subject: Chemistry		
Course Code:	Course Title: Analytical Procedures-IV	

Course outcomes: Upon completion of this course, the students will have the knowledge and skills to determine the heat of neutralization, solubility of organic compounds by titration method. They will be able to estimate different metal ions through gravimetric exercise. Spectroscopic and chromatographic exercise will train them to interpret the spectral data and chromatograms of organic compounds and will make them job ready for suitable industries.

Credits:2	Compulsory
Max. Marks: 12+38	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Laboratory hazards and safety precautions	6
2	Physical exercise: Determination of solubility of organic compound (viz. oxalic acid) in water by titration method. Determination of Heat of neutralization.	18
3	Spectroscopic exercise: Functional Group determination by UV and IR Spectroscopy; analysis of organic compounds including alcohols, phenols, carboxylic acids, carbonyl compounds, nitrogen containing compounds.	18
4	Inorganic Exercise: Gravimetric analysis of any one or two metal ions; Ba ²⁺ , Fe ³⁺ , Ni ²⁺ , Cu ²⁺ , Zn ²⁺ etc.	10
5	Chromatographic technique:	8

	Demonstrative Chromatography- paper chromatography (Analytical separation of organic compounds- Amino acids/ dyes)	
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Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in viva voce, record and overall performance.

Evaluation method	Marks
Attendance	06 marks
Viva voce/Record and overall performance	06 marks

Course prerequisites: To study this course, a student must have opted Sem-VI Theory Paper-1 &2

Further Suggestions:

One exercise each from inorganic analysis (quantitative), Spectroscopy/ Chromatography and physical exercise shall be given in the examination.

Distribution of marks shall be as given below:

1. Inorganic exercise	13
2. Spectroscopy/ Chromatography	10
3. Physical exercise	10
4. Viva	05
5. Home assignment/internal assessment, lab record and attendance	12

Note:

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded.*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 05(five) hours.*
- *Marks obtained in the practical examination have to be submitted to the Head of the department/ Principal of the College. The Head of the Department/Principal of the College will make necessary arrangement for uploading the marks onto the University exam portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Kumaun University, Nainital*

Minor/Elective courses

Semester-I/II

Paper-I (Theory)

Course Title: Basics of Analytical Chemistry-I

Programme/Class: Certificate in Introductory	Year: First	Semester: First/Second
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Chemistry	
Paper-I Theory Subject: Chemistry	
Course Code:	Course Title: Basics of Analytical Chemistry-I

Course outcomes: Upon completion of this course, the students will be able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.

Credits:4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Analytical approaches: Types of errors, precision & accuracy, absolute and relative uncertainty. Significant figures; significant figures in Arithmetics-addition, subtraction, multiplication and division. Mean and standard deviation.	12
2	Laboratory Apparatus: Laboratory burner; Bunsen burner, air flow regulation, obtaining warm gentle flame with the burner, hottest flame of the burner. Cutting and bending of glass tubing/glass rod, fire polishing of glass tubing or rod.	12
3	Steps in Chemical Analysis: Sampling, sample preparation, analysis, interpretation and preparation of report.	8
4	Use of Measuring Equipments: Pipette, burette, chemical balance, least count.	8
5	Chemical Concentration: Normality, molarity, preparation of solution of defined normality/molarity of a given compound and from a given solution of different strength, percent composition, part per million (ppm), part per billion (ppb), calculations.	12
6	Titration: Types of titrations, end point, equivalence point, Indicators-types and theory.	8

Recommended Texts:

- i. Nivaldo, J. and Tro, Ho Yu Au-Yeung, Introductory Chemistry, Pearson India Education, 2017, 5th edition.
- ii. Timberlake, K. C., and Timberlake, W., Basic Chemistry, Pearson India Education, 2017, 4th edition.
- iii. Pavia, D.L., Lampman, G. M., Kriz, G. S, and Engel, R.G., Microscale and Macroscale Techniques in the Organic Laboratory, Harcourt College Publishers, 2001, 1st edition.
- iv. Harris, D. C., Exploring Chemical Analysis, W. H. Freeman and Company, New York, 1993, 4th edition.
- v. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman and Company, New York, 2010, 8th edition.

Suggestive digital platforms web links

1. <https://www.labster.com/chemistry-virtual-labs/>

2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:

Further Suggestions:

Semester-I/II
Paper-II (Theory)
Course Title: Basics of Analytical Chemistry-II

Programme/Class: Certificate in Introductory Chemistry	Year: First	Semester: First/Second
Paper-II Theory Subject: Chemistry		
Course Code:	Course Title: Basics of Analytical Chemistry-II	

Course outcomes: Upon completion of this course, the students will be able to understand the analytical principles behind polarimetry, refractometry, distillation, crystallization and extraction. Further, the students will be able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.

Credits:4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

S. No.	Contents	Contact Hours/ Hours

1	Physical Constants: Melting points, melting point theory, mixture melting point, 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.	12
2	Polarimetry and Refractometry: Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity. Refractometry: Refractometry; The refractive index, Refractometer.	12
3	Electromagnetic Radiation: Properties, absorption of light, transmittance, absorbance and Beer's Law. Spectrophotometer-Single beam and double beam instruments.	8
4	Distillation: Simple distillation, distillation theory, fractional distillation, difference between simple and fractional distillation, vapour-liquid composition diagram, Raoult's Law, types of fractionating columns, column efficiency, azeotropes.	10
5	Crystallization and Filtration: Filtration-Selection of suitable solvent/s, purification of compounds. Filtration-Gravity filtration, filter papers, vacuum filtration, aspirator, working of aspirator.	10
6	Solubility and Extraction: Solubility-Definition, predicting solubility behaviour, water as a solvent, organic solvents. Extraction-Theory, distribution coefficient, separation and drying agents.	8

Recommended Texts:

- Nivaldo, J. and Tro, Ho Yu Au-Yeung, Introductory Chemistry, Pearson India Education, 2017, 5th edition.
- Timberlake, K. C., and Timberlake, W., Basic Chemistry, Pearson India Education, 2017, 4th edition.
- Pavia, D.L., Lampman, G. M., Kriz, G. S, and Engel, R.G., Microscale and Macroscale Techniques in the Organic Laboratory, Harcourt College Publishers, 2001, 1st edition.
- Harris, D. C., Exploring Chemical Analysis, W. H. Freeman and Company, New York, 1993, 4th edition.
- Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman and Company, New York, 2010, 8th edition.

Suggestive digital platforms web links

- <https://www.labster.com/chemistry-virtual-labs/>
- <https://www.vlab.co.in/broad-area-chemical-sciences>
- <http://chemcollective.org/vlabs>
- https://onlinecourses.swayam2.ac.in/ugc19_bt16/preview

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities)	05 marks
Attendance	05 marks

Course prerequisites: To study this course, a student must have studied the chemistry of class 12th standard

Suggested equivalent online courses:

Further Suggestions:

**Semester-III/IV
Paper-I (Theory)**

Course Title: Chemistry of d-Block Elements, Quantum Chemistry and Spectroscopy

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Third/Four
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: Chemistry of d-Block Elements, Quantum Chemistry and Spectroscopy	

Course outcomes: After completion of this course, the students will be able to understand the chemistry of d- and f-block elements, coordination compounds, quantum mechanical aspects of spectroscopy. The students will also able to understand principles and applications of spectroscopic techniques and photochemistry.

Credits:4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Transition Metal Elements: Introduction to transition metals. Transition and inner transition elements. Chemistry and trends of properties (Ability to form complexes, stability, variable oxidation states) of d-block and f-block elements. Applications.	12
2	Coordination Compounds: Introduction, isomerism, IUPAC system of nomenclature, VBT, CFT, distortions in coordination	14

	compounds.	
3	Quantum Mechanical Approach: Quantum mechanical background behind molecular characterization. Quantum mechanical approach for molecular spectroscopy. Interaction between matter and electromagnetic radiation-wave-particle duality, particle in 1-D box, normalization of wave functions, Born-Oppenheimer approximation.	16
4	Spectroscopy: Principle and Applications. Microwave spectroscopy- Rotational and Vibrational spectra, Infrared Spectroscopy, Electronic spectroscopy,	10
5	Photochemistry: Introduction of photochemistry, Principle and Applications of photochemistry.	8

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- viii. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- ix. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.
- x. Clark, J. H., and Macquarrie, D.J., Handbook of Green Chemistry and Technology, Wiley-Blackwell, 2002.
- xi. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
- xii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2008, 2nd edition.

Suggested online links:

1. https://onlinecourses.nptel.ac.in/noc22_cy23/preview

2. https://www.swayamprabha.gov.in/asset/new_team/images/course_files/ch-15/S21%20QUANTUM%20MECHANICS%20AND%20MOLECULAR%20SPECTROSCOPY.pdf
3. https://onlinecourses.nptel.ac.in/noc19_cy19/preview
4. <https://www.classcentral.com/course/swayam-transition-metal-organometallic-chemistry-principles-to-applications-10047>
5. https://www.swayamprabha.gov.in/index.php/program_data/flipMore/S13/15

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities)	05 marks
Attendance	05 marks

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:

https://onlinecourses.swayam2.ac.in/cec21_ma16/preview

Further Suggestions:

Semester-III/IV Paper-III (Theory)

Course Title: Coordination Chemistry, States of Matter and Chemical Kinetics

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Third/Four
Paper-II Theory Subject: Chemistry		
Course Code:	Course Title: Coordination Chemistry, States of Matter and Chemical Kinetics	

Course outcomes: After completion of this course, the students will be able to understand the chemistry of d- and f-block elements, coordination compounds, quantum mechanical aspects of spectroscopy. The students will also be able to understand principles and applications of spectroscopic techniques and photochemistry.

Credits:4	Elective
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 60

Unit	Contents	Number of Hours
1	Transition Metal Elements: Introduction to transition metals. 3d series -Chemistry and trends of properties (Electronic configuration, atomic and ionic radii, density, melting and boiling point, ability to form complexes, stability, variable oxidation states, colour, magnetic properties). Applications.	15
2	Coordination Chemistry: Introduction, Definition, terminology (ligand, coordination number, coordination sphere, complex ion etc.), VBT, CFT, crystal field splitting of octahedral, tetrahedral and square planar complexes, Jahn Teller distortion, Applications.	16
3	States of Matter: Gas, liquid and solid states. Kinetic theory of gases, properties of gas, liquid and solid, liquid crystals, crystal defects	13
4	Chemical Kinetics: Introduction, rate of a reaction, factors influencing the rate of a reaction—concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates of simple reaction, Molecularity, Order of reaction- zero order, first order, second order, pseudo-order.	16

Books Recommended:

- i. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
- ii. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
- iii. Madan, R.L., "Chemistry for Degree Students, B. Sc. Third Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition.
- iv. Madan, R.D., Malik, U.M. and Tuli, G.D., "Selected topics in Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2010.
- v. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
- vi. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
- vii. Finar, I.L., "Organic Chemistry", Pearson Education India, 2002, 6th edition.
- viii. Mukerji, S.M., "Reaction mechanism in Organic Chemistry", Laxmi Publications, 2007, 3rd edition.
- ix. Loudon, G. Marc, "Organic Chemistry", Oxford University Press, 2008, 4th edition.

- x. Clark, J. H., and Macquarrie, D.J., Handbook of Green Chemistry and Technology, Wiley-Blackwell, 2002.
- xi. Anastas, P.T., and Williamson, T.C. Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Oxford University Press, New York, 1999.
- xii. Ozin, G.A., Arsenault, A.C. and L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, 2008, 2nd edition.

Suggested online links:

1. <https://www.classcentral.com/course/swayam-transition-metal-organometallic-chemistry-principles-to-applications-10047>
2. https://onlinecourses.nptel.ac.in/noc19_cy19/preview
3. https://www.swayamprabha.gov.in/index.php/program_data/flipMore/S13/15
4. <https://www.classcentral.com/course/swayam-chemistry-xi-part-i-17540>
5. https://onlinecourses.nptel.ac.in/noc20_cy09/preview
6. <http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch12/trans.php>
7. http://www.chemistry.wustl.edu/~edudev/LabTutorials/naming_coord_comp.html
8. <http://chemed.chem.wisc.edu/chempaths/GenChem-Textbook/Coordination-Compounds-1052.html>
9. <http://wwwchem.uwimona.edu.jm/courses/CFT.html>
10. <http://scienceworld.wolfram.com/chemistry/CrystalFieldTheory.html>
11. www.thermopedia.com/content/1232/
12. http://www.pci.tu-bs.de/aggericke/PC4e/Kap_IV/Sym-Op.html
13. www.highered.mcgraw-hill.com/sites/dl/free/0073402680/.../Chapter_13.pdf

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities) and Attendance	10 marks

Course prerequisites: To study this course, a student must have had the chemistry in class 12th

Suggested equivalent online courses:

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

Further Suggestions:

Semester-III/IV
Paper-I (Theory)
Course Title: Industrial Inorganic Chemistry

Programme/Class: Diploma in Chemical Science	Year: Second	Semester: Third/Fourth
Paper-I Theory Subject: Chemistry		
Course Code:	Course Title: Industrial Inorganic Chemistry	

Course outcomes: This paper provides detailed knowledge of synthesis of various class of industrially important inorganic compounds which will help the students to work in chemical-based industries. It relates and gives an analytical aptitude for synthesizing various industrially important compounds. This paper also provides a detailed knowledge on the applications of various inorganic materials.

Credits:3	Skill Development Course
Max. Marks: 25+75	Min. Passing Marks:.....

Total Number of Hours = 45

Unit	Contents	Number of Hours
1	Chemicals and Industry: Importance of chemical industry, chemical, types of chemicals, water.	5
2	Inorganic Compounds I: Hydrogen, inorganic peroxide compounds, nitrogen compounds, chloramine, hydroxylamine, nitric acid, uses and importance. Phosphorus and its compounds.	8
3	Halogen Compounds: Nitrogen and potassium fertilizers	5
4	Metals and their Compounds: Lithium, sodium, potassium, magnesium, calcium, barium, chromium, manganese, silicon.	7
5	Inorganic Solids: Glass, zeolites, inorganic fibres, ceramics.	5
6	Carbon modifications: Glassy carbon, foamed carbon, carbon black, activated carbon.	5
7	Metallic Hard Materials: Carbides, borides, silicides.	5
	Inorganic pigments: Fillers, types of pigments (oxide, luminescent, corrosion protection, magnetic).	5

Books Recommended:

- i. Buechel, K. H., Moretto, H-H., Woditsch, P., Industrial Inorganic Chemistry, Wiley-VCH, 2008, 2nd edition.
- ii. Swaddle, T. W., Inorganic Chemistry: An Industrial and Environmental Perspective, *Journal of Chemical Education*, 1997, 74 (12), 1399.

Suggested online links:

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

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.

Evaluation method	Marks
Mid-term exam/ in-class or on-line tests/ home assignments/ group discussions/ oral presentations	15 marks
Overall performance throughout the semester, Discipline, participation in different activities)	05 marks
Attendance	05 marks

Course prerequisites: To study this course, a student must have studied the chemistry of class 12th standard

Suggested equivalent online courses:

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

<https://nptel.ac.in/courses/104/105/104105103/>

Further Suggestions: