Year-2023-2024
Syllabus of B.Sc. Programme: [Subject Name: Chemistry]
In accordance with NEP-2020

Year	Sem.	Course Code	Paper Title	Theory/Practical	Max. Marks.	Credits
1	I	UGCHE -101N	INORGANIC CHEMISTRY I (BASIC INORGANIC CHEMISTRY)	Theory	100	2
		UGCHE -101P(N)	Practical Work	Practical	100	2
1	II	UGCHE -102N	ORGANIC CHEMISTRY I (BASIC ORGANIC CHEMISTRY)	Theory	100	2
		UGCHE -102P(N)	Practical Work	Practical	100	2
		Skill Enhancement Course				
		SBSCHE-02N	ADVANCED ANALYTICAL TECHNIQUES	Theory	100	4
2	III	UGCHE -103N	PHYSICAL CHEMISTRY I (BASIC PHYSICAL CHEMISTRY)	Theory	100	2
		UGCHE -103P(N)	Practical Work	Practical	100	2
		Skill Enhancement Course				
		SBSCHE-01N	ORGANIC CHEMISTRY II (ADVANCE ORGANIC CHEMISTRY)	Theory	100	4
2	IV	UGCHE -104N	INORGANIC CHEMISTRY II (ADVANCE INORGANIC CHEMISTRY)	Theory	100	2
		UGCHE -104P(N)	Practical Work	Practical	100	2
Discipline Centric Elective Course						
3	V	DCECHE -105N	PHYSICAL CHEMISTRY II (ADVANCE PHYSICAL CHEMISTRY)	Theory	100	2
		DCECHE -106N	INORGANIC CHEMISTRY III (SELECTED TOPICS IN INORGANIC CHEMISTRY)	Theory	100	2
		DCECHE -107P(N)	Practical Work	Practical	100	2
Discipline Centric Elective Course						
3	VI	DCECHE -108N	ORGANIC CHEMISTRY III (SELECTED TOPICS IN ORGANIC CHEMISTRY)	Theory	100	2
		DCECHE -109N	PHYSICAL CHEMISTRY III (SELECTED TOPICS IN PHYSICAL CHEMISTRY)	Theory	100	2
		DCECHE -110P(N)	Practical Work	Practical	100	2
				Total Marks/Credit	**1600**	**32**

Syllabus for [B.Sc.]: Subject: [Chemistry]

Course prerequisites: 10+2 with Chemistry		
Programme:B.Sc.	Year: 1	Semester: I
Subject: Chemistry		
Course Code: UGCHE -101N	Course Title: INORGANIC CHEMISTRY I (BASIC INORGANIC CHEMISTRY)	

Course Objectives:

To provide knowledge about structure of atoms and associated important rules, importance of chemistry of elements, bonding and properties of any compound/material. Several parameters associated with elements, Solid state chemistry and chemistry of elements belonging to s-block, noble gases and main group.

Course Outcomes:

CO-1 Structure of atoms and associated important rules, importance of chemistry of elements.
CO-2 Ionic, covalent and non-covalent bonding which always play pivotal role in deciding the chemistry and properties of any compound/material.
CO-3 Periodic properties of elements and several parameters associated with elements
CO-4 Solid state chemistry which forms the basis of the development of targeted crystalline solids inculcating varied defects which induces variety of materials properties viz. piezoelectricity.
CO-5 Chemistry of elements belonging to s-block, noble gases and main group.

Credits: 2	**Type of Course:** Core
Max. Marks: 100	Min. Passing Marks: 36

Block 1	
Unit I	**Atomic Structure** Historical concepts of atomic structure. Idea of de-Broglie's matter waves, Heisenberg's uncertainly principle, significant of ψ and ψ^2, Schrodinger's wave equation for H atom; Radial and angular wave functions: quantum numbers and shapes of s, p, d and f orbitals; Aufbau and Pauli Exclusion Principle. Variation of orbital energies with atomic number and energy level diagram; Long form of periodic table based on electronic configuration.
Unit II	**Periodic properties of elements** Types of radii (Covalent, Crystal and Van der Waal); Electron affinity and its variation; Ionisation potential, Factors affecting the magnitude of I.P., Concept of effective nuclear charge and shielding effect (Calculation of Screening constant with Slater's rules.); Electronegativity (Pauling, Mulliken and Allred Rochow scale) and its variation.
Unit III	**Chemical Bonding** (i) **Ionic Bonding:** Conditions favouring the ionic bond, radius ratio and structure of ionic solids. Concept of lattice energy and Born-Haber cycle, Polarisation of ions and Fajan's rules. (ii) **Covalent and brief idea of other bonds:** Concept of directed valence bond theory (VBT) and hybrid orbital description (sp, sp^2, sp^3, sp^3d and sp^3d^2) using simple illustrations, determination of the shapes of molecules and ions viz. NH_3, H_2O, H_3O^+, SF_4, ClF_3, ICl^{2-} and I^{3-} by VSEPR concept, Concept of maximum covalency. Odd electron bond, three centre bond. MO Theory, homonuclear (H_2,H^{2+}, B_2, N_2, O_2, Cl_2) and heteronuclear (CN, CO and

	NO) diatomic molecules, bond strength, and bond energy, percent ionic character from dipole moment and electronegativity. Multicenter bonding in electron deficient molecules. (iii) **Weak Interactions**: Hydrogen bonding (Inter and Intra Molecular), Vander Waals forces. (iv) **Metallic Bond:** Theories of bonding in metals; Free electron, VB and Band theories.
Block 2	
Unit IV	**General Studies of s block elements** Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls; Chemical reactivity of alkali and earth alkaline metals; Uses of s-block elements and their compounds (Li, Na and K only), Organometallic compounds of Li, Na, K, Be and Mg. Polyether complexes (Crown ether complexes) of alkali metals; Extraction and isolation of Li, Be and Ra from their minerals.
Unit V	**General Studies of p- block elements** Group wise discussion with respect to electronic configuration, ionisation potential, electron affinity, electronegativity, atomic and ionic radii, oxidation states, catenation and inert pair effect (wherever applicable). Preparation, properties and structures of diborane, borazine, hydrazine, interhalogens and polyhalides and fluorides of xenon. Structure and basicities of oxyacids of B, P and S. Structural features of hydrides, halides, oxides and oxyacids.
Unit VI	**Oxidation and Reduction** Electrode potential, electrochemical series and its applications. EMF diagrams and their utility. Principle involved in the extraction of the elements.

Suggested Text Book Readings:

Text Books (Theory Courses):

(a) Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.

(b) Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.

(c) Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.

(d) Chemistry for degree students, R. L. Madan

Reference Books:

(a) Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.

(b) Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.

(c) Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.

(d) Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.

(e) Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.

(f) Inorganic Chemistry, A.G. Sharpe, ELBS

(g) Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx

https://nptel.ac.in/courses/104/106/104106096/

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

https://nptel.ac.in/courses/104/103/104103071/#

Electronic media and other digital components in the curriculum:

Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2020

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year: 1</td><td>Semester: 1</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: UGCHE 101P(N)</td><td colspan="2">Course Title: UGCHE-LAB-WORK-I</td></tr>
<tr><td colspan="3">Course Objectives:
To understand basic knowledge and skills about laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1 Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products.</td></tr>
<tr><td colspan="2">Credits: 2</td><td>Type of Course: Core</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">General – Principle and working of Chemical balance. Calibration of fractional weights and thermometer.</td></tr>
<tr><td>Unit II</td><td colspan="2">Inorganic Chemistry
Qualitative analysis of an inorganic mixture containing five radicals out of the following preferably by semi-micro technque (including insoluble substances):
NH_4^+, Na^+, K^+, Mg^{++}, Ca^{++}, Sr^{++}, Ba^{++}, Zn^{++}, Mn^{++}, Ni^{++}, Co^{++}, Al^{+++}, Fe^{+++}, Cr^{+++}, Cu^{++}, Bi^{++}, Hg^{+}, Hg^{++}, Cd^{++} As^{+++}, Sb^{+++}, Sn^{++}, Pb^{+} ,Pb^{++}, Ag^{+}, CO_3^{2-},NO^{2-}, S^{2-}, SO_3^{2-},SO_4^{2-}, F^- , Cl^-, Br^-, NO_3^-, CH_3COO^- , Borate, Oxalate, and Phosphate.</td></tr>
<tr><td colspan="3">Suggested Text Book Readings:
1. Mendham, J. Vogel’s Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
3. Harris, D.C . Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
4. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition
Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University
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</td></tr>
<tr><td colspan="3">This course can be opted as an elective by the students of following subjects:</td></tr>
<tr><td colspan="3">Suggested equivalent online courses (MOOCs) for credit transfer: NA</td></tr>
<tr><td colspan="3">Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/ Other electronic and digital contents</td></tr>
<tr><td colspan="2">Name of electronic media: e-SLM</td><td>Year of incorporation: 2021</td></tr>
</table>

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: 10+2 Chemistry as subject</td></tr>
<tr><td>Programme:B.Sc.</td><td>Year:1</td><td>Semester:2</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: UGCHE-102N</td><td colspan="2">Course Title: ORGANIC CHEMISTRY I (BASIC ORGANIC CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
To understand different organic compounds with respect to the functional groups and basics of chemical reactions.
To understand different principles of organic chemistry and predict outcomes and derive mechanism of various types of organic reactions.
To understand the concept of Aromaticity of benzenoids & nonbenzenoids. The preparation, reactivity and structure of aromatic compounds.
To learn the preprations, reactivity & stereochemistry of SN^1 &SN^2 reactions of Halogen compounds.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1 Understand different organic compounds with respect to the functional group and thus capable to name the organic compounds as per IUPAC nomenclature.
CO-2 Understand the basics of chemical reactions i.e. Substrate and Reagent, types of Reagents, Electrophilic and Nucleophilic Homolytic and heterolytic fission. Electron mobility, Inductive effect etc.
CO-3 Recognize and draw constitutional isomers, stereoisomers, including enantiomers and diasteromers, racemic mixture and meso compounds.
CO-4. Understand fundamental principles of organic chemistry and predict outcomes and derive mechanism of various types of organic reactions.
CO-5 Understand various types of reactive intermediates and factors affecting their stability
CO-6 Understand the nomenclature, synthesis, isomerism and physical properties of alkanes and cycloalkanes.
CO-7 Understand the concept of Aromaticity of benzenoids & nonbenzenoids. The preparation, reactivity and structure of aromatic compounds.
CO-8 Learn the preprations, reactivity & stereochemistry of SN^1 &SN^2 reactions of Halogen compounds.</td></tr>
<tr><td colspan="2">Credits:2</td><td>Type of Course: Core</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Structure and Bonding
Atomic orbitals, hybridization, orbital representation of methane, ethane, ethyne and benzene. Polarity of bonds: Inductive, resonance and steric effects hyperconjugation, and their influence on acidity and basicity of organic compounds. Homolysis and Heterolysis; Concept of Carbocation, Carbanion and Free radicals.</td></tr>
<tr><td>Unit II</td><td colspan="2">Mechanism of Organic Reactions and Reaction Intermediates
Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, hemolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations.</td></tr>
</table>

	Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning format charges on intermediates and other ionic species. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).
Unit III	**Alkanes and Cycloalkanes** IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atom in alkanes, Isomerism in alkanes, sources methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.
Block 2	
Unit IV	**Stereochemistry of Organic Compounds** Concept of isomerism. Types of isomerism. Optical isomerism – elements of symmetry, molecular chirality, enantionmers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclaute. Geometric isomerism – determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism -- conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.
Unit V	**Alkenes, Cycloalkenes, Dienes and Alkynes** Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes – mechanism involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroborationoxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO4. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization, Chemical reaction – 1,2 and 1,4 additions, Diets-Alder reaction. Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.
Unit VI	**Arenes and Aromaticity** Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and kekule structure. Stability and

	carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromaticity: the Huckel 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. Birch reduction. Methods of formation and chemical reactions of alhylbenzenes, alkynylbenzenes and biphenyl.
Unit VII	**Alkyl and Aryl Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams. Polyhalogen compounds: chloroform, carbon tetrachloride. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

Suggested Text Book Readings:
Text Books (Theory Courses):
(a) Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
(b) Organic Chemistry, M.K. Jain, Shoban Lal& Co.
(c) Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.
Reference Books:
(a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
(b) Organic Chemistry, L.G. Wade Jr. Prentice Hall.
(c) Fundamentals of Organic Chemistry Solomons, John Wiley.
(d) Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
(e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
(f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/105/104105124/
https://nptel.ac.in/courses/103/106/105106204/
https://nptel.ac.in/courses/104/105/104105034/
https://nptel.ac.in/courses/104/103/104103121/
https://nptel.ac.in/courses/104/102/104102016/
https://nptel.ac.in/courses/104/106/104106106/
https://nptel.ac.in/courses/104/105/104105120/

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer:

1. **Mechanisms in Organic Chemistry, Prof. Nandita Madhavan, NPTEL, https://onlinecourses.nptel.ac.in/noc22_cy42/preview**

Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: 10+2 Chemistry as subject</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:1</td><td>Semester:2</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: UGCHE 102P (N)</td><td colspan="2">Course Title: UGCHE-LAB-WORK-II</td></tr>
<tr><td colspan="3">Course Objectives:
This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO1- Preparation of organic compounds
CO2- Crystallization and determination of melting points.</td></tr>
<tr><td colspan="2">Credits:2</td><td>Type of Course: Core</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Organic Chemistry-I
(a) Preparation of organic compounds:
1. Acetanilide
2. p-bromoacetanilide
3. picrates</td></tr>
<tr><td>Unit II</td><td colspan="2">Organic Chemistry-II
(b) Crystallization and determination of melting point.
1. Phthalic acid from hot water (using fluted filter paper and stemless funnel)
2. Acetanilide from boiling water
3. Naphthalene from ethanol
4. Benzoic acid from water</td></tr>
<tr><td colspan="3">Suggested Text Book Readings:
1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry</i, Pearson Education.
3. Vogel’s Qualitative Inorganic Analysis, Revised by G. Svehla.
4. Vogel, A.I. A Textbook of Quantitative Analysis, ELBS. 1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel’s Textbook of Practical Organic Chemistry</i, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry</i,Universities Pres
7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,
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</td></tr>
<tr><td colspan="3">This course can be opted as an elective by the students of following subjects:</td></tr>
<tr><td colspan="3">Suggested equivalent online courses (MOOCs) for credit transfer:</td></tr>
<tr><td colspan="3">Electronic media and other digital components in the curriculum:
Choose any one or more than:e-SLM/ Other electronic and digital contents</td></tr>
<tr><td colspan="2">Name of electronic media: e-SLM</td><td>Year of incorporation: 2021</td></tr>
</table>

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="4">Course prerequisites: 10+2 Chemistry as subject</td></tr>
<tr><td colspan="2">Programme: B.Sc.</td><td>Year:1</td><td>Semester:2</td></tr>
<tr><td colspan="4">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: SBSCHE -02N</td><td colspan="2">Course Title: ADVANCED ANALYTICAL TECHNIQUES</td></tr>
<tr><td colspan="4">Course Objectives:
To gain basics about analytical chemistry plays an enormous role in our society, such as in drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of great importance in different research areas.</td></tr>
<tr><td colspan="4">Course Outcomes:
CO1- Students will be able to explore Analytical chemistry is a science that is directed towards creating new knowledge so that chemical analysis can be improved to respond to increasing or new demands.
CO2- Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
CO3- Students will be able to function as a member of an interdisciplinary problem solving team.
CO4- Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems
CO5- Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques
CO6- To develop basic skills required for purification, solvent extraction, TLC and column chromatography</td></tr>
<tr><td colspan="3">Credits: 4</td><td>Type of Course: Core</td></tr>
<tr><td colspan="3">Category of Course</td><td>Value-added / employability/</td></tr>
<tr><td colspan="2">Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="3"></td></tr>
<tr><td>Unit I</td><td colspan="3">Statistical Analysis
Definition of terms mean and median, precision, standard deviation, relative standard deviation, accuracy, absolute error, types of error in experimental data, determinate (systematic), indeterminate (or random) and gross, sources of errors and effects upon the analytical results, methods for reporting analytical data, statistical evaluation of data, indeterminate errors, uses of statistics.</td></tr>
<tr><td>Unit II</td><td colspan="3">Volumetric analysis
General principles of acid – base titration, precipitation titration, oxidation-reduction titration, iodimetry and iodometry, complexometric titrations, use of EDTA for the determination of Ca^{2+} and Mg^{2+} and hardness of water, types of EDTA titrations, metal ion indicators.</td></tr>
<tr><td>Unit III</td><td colspan="3">Gravimetric analysis
Precipitation from homogeneous medium, purity of precipitates, co-precipitation, post-precipitation, washing and ignition of precipitates, contamination and their removal.</td></tr>
<tr><td>Block 2</td><td colspan="3"></td></tr>
<tr><td>Unit IV</td><td colspan="3">Separation techniques
Principle, technique and analytical applications of the following:
(a) Solvent extraction
(b) Chromatography (Paper, Thin Layer, Column and HPLC)
(c) Ion exchange</td></tr>
<tr><td>Unit V</td><td colspan="3">Nano Chemistry</td></tr>
</table>

	Nanomaterials – An Introduction, Size Effects, Defining Nanodimensional Materials, Potential Uses for Nanodimensional Materials, The General Methods Available for the Synthesis of Nanodimensional Materials, Precipitative Methods, Reactive Methods in High Boiling Point Solvents, Hydrothermal and Solvothermal Methods, Gas-Phase Synthesis of Semiconductor Nanoparticles, Synthesis in a Structured Medium, The Suitability of Such Methods for Scaling, Conclusions and Perspectives on the Future, Oxide Nanoparticles, Nanotubes and Nanowires. Study of different characterization tools (XRD, TEM, SEM, AFM, etc.) for Nanomaterials.

Suggested Text Book Readings:

1. Alberty,R A, Physical Chemistry,4 th editionWiley Eastern Ltd ,2001.
2. Atkins,P W,the elements of physical chemistry,Oxford ,1991
3. Barrow,G .M,International student Edition .McGraw Hill, McGraw-Hill,1973.
4. Cotton,F.A, Wilkinson,G and Gaus,P. L ,Basic Inorganic Chemistry,3rd Edition ,Wiley 1995
5. Lee,J.D, Concise Inorganic Chemistry 4th Edition ELBS,1977
6. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press 2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John
Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont,
California, USA, 1988.
10. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer:

1. **Analytical Chemistry, Prof. Debashis Ray, https://onlinecourses.nptel.ac.in/noc22_cy61/preview**
2. **Spectroscopic Techniques for Pharmaceutical and Biopharmaceutical Industries, Prof. Shashank Deep, https://onlinecourses.nptel.ac.in/noc22_cy54/preview**

Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:2</td><td>Semester:3</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: UGCHE -103N</td><td colspan="2">Course Title: PHYSICAL CHEMISTRY I (BASIC PHYSICAL CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
To get basic knowledge about computers and mathematical functions and understanding of gaseous state, critical phenomenon, liquid state, solid state, colloidal state and liquid crystals.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1- Students would gain knowledge regarding the basic of computers and mathematical concepts of log, permutation and combination, differential and integration of some relevant functions.
CO-2- Student would gain understanding of gaseous state, critical phenomenon, liquid state, solid state, colloidal state and liquid crystals.
CO-3- It would help students recognize the importance of chemical kinetics and catalysis.</td></tr>
<tr><td colspan="2">Credits:2</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Category of Course</td><td>Value-added / employability/</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Mathematical Concepts and Computers
Unit 1: Mathematical Concepts and Computers
(A) Mathematical Concepts
Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like $f_{(x)}$, e_x, x_n, sin x, log x; maxima and minima, partial differentiation and eciprocity relations. Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability and Regrrations.
(B) Computers
General introduction to computers, different components of a computer, hardware and software, input-output devices; binary numbers and arithmetic; introduction to computer languages. Programming, operating systems. Use and application of different software in the Chemistry.</td></tr>
<tr><td>Unit II</td><td colspan="2">Gaseous and Liquid States
(A) Gaseous States
Postulates of kinetic theory of gases, deviation from ideal behaviour, van der Waals equation of state.
Critical Phenomena : PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.
Molecular Velocities : Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases.
(B) Liquid State
Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases.</td></tr>
</table>

	Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholesteric phases and applications.
Unit III	**Solid State** Definition of space lattice and unit cell. **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:** Derivation of Bragg's equation. Determination of crystal structure of NaCl, CsCl and KCl. A brief introduction to point defects in crystals, semiconductors, superconductors and nanomaterials (only qualitative idea).
Block 2	
Unit IV	**Thermodynamics – I** Definition of terms: system, surroundings, open system, isolated system, intensive and extensive properties, State and path functions and their differentials, reversible and irreversible processes, Concept of heat and work. *First Law of Thermodynamics*: Concepts of internal energy and enthalpy, heat capacities at constant volume and constant pressure and their relationship. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for a reversible process. *Thermochemistry :* standard state, standard enthalpy of formation- Hess's Law of constant heat summation and its applications, heat of reaction at constant pressure and at constant volume, Bond dissociation energy and its calculation from thermo-chemical data, Kirchhoff's equation.
Unit V	**Electrochemistry – I and Solution** Electrical transport - conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Activity and activity coefficient. Transport number, definition and determination by Hittorf method and moving boundary method. **Solution** Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.
Unit VI	**Chemical Kinetics and Catalysis** Rate of a reaction- factors influencing the rate of a reaction such as concentration, temperature, pressure, solvent, light and catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions - zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction - differential method, method of integration, method of half life

	period and isolation method. Radioactive decay as a first order phenomenon. Experimental methods for the studies of chemical kinetics. **Theories of chemical kinetics**: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy, Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. **Catalysis:** Characteristics of catalyzed reactions, classification of catalysis, Industrial catalysts and enzyme kinetics.

Suggested Text Book Readings:

Text Books (Theory Courses):

a. Physical Chemistry, Puri Sharma & Pathania.

b. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.

c. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill

b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.

c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.

d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.

e. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.

f. Physical Chemistry, Glasstone

Suggestive digital platforms web links

1. https://www.coursera.org/courses?query=chemistry&languages=en
2. https://www.mooc-list.com/tags/physical-chemistry
3. https://www.coursera.org/learn/physical-chemistry
4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer:

1. **Chemical Crystallography, Prof. Angshuman Roy Choudhury, https://onlinecourses.nptel.ac.in/noc22_cy48/preview**

Electronic media and other digital components in the curriculum:

Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="4">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td colspan="2">Programme: B.Sc.</td><td>Year:2</td><td>Semester:4</td></tr>
<tr><td colspan="4">Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code: UGCHE -104N</td><td colspan="2">Course Title: INORGANIC CHEMISTRY II (ADVANCE INORGANIC CHEMISTRY)</td></tr>
<tr><td colspan="4">Course Objectives:
• To give basic knowledge about Chemistry of transition and inner-transition elements.
• To give basic knowledge about Concepts of coordination chemistry and their applications
• To give basic knowledge about Importance and different chemical aspects of non-aqueous solvents</td></tr>
<tr><td colspan="4">Course Outcomes:
CO-1 Chemistry of transition and inner-transition elements. These insights are important as they help in the rational selection of the cations of these elements for tailor-made syntheses of newer complexes
CO-2 Concepts of coordination chemistry and their applications
CO-3 Importance of different acid-base concepts which forms the basis of rational ligand designing and coordination complex formation for specific bioinorganic, materials and optoelectronic applications.
CO-4 Importance and different chemical aspects of non-aqueous solvents which now-a-days are gaining importance in varied targeted syntheses of drugs and materials for technological applications</td></tr>
<tr><td colspan="2">Credits:2</td><td colspan="2">Type of Course: Core</td></tr>
<tr><td colspan="2">Category of Course</td><td colspan="2">value-added / employability/</td></tr>
<tr><td colspan="2">Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="3"></td></tr>
<tr><td>Unit I</td><td colspan="3">Molecular Symmetry
Symmetry Elements, Symmetry Operations and Point groups of different compounds.
Character Tables of H_2O and NH_3.</td></tr>
<tr><td>Unit II</td><td colspan="3">Chemistry of Transition Elements
Position in periodic table, electronic configuration, General Characteristics, viz., atomic and ionic radii, variable oxidation states, ability to form complexes, formation of coloured ions and catalytic behaviour. General comparative treatment of 4d and 5d (Zr/Hf , Nb/Ta , Mo/W) elements with their 3d analogues with respect to ionic radii, oxidation states and magnetic properties.</td></tr>
<tr><td>Unit III</td><td colspan="3">Coordination Compounds
(i) Definition of ligand: Classification with respect to denticity. (Examples of mono- to hexadentate ligands).
(ii) IUPAC-Nomenclature of Transition Metal complexes.
(iii) Werner’s postulates, Sidgwick’s effective atomic number concept and limitations, Valence Bond Theory of coordination compounds, Stereochemistry of coordination numbers two, four, five and six with examples of hybrid orbital participation in the following :</td></tr>
</table>

	$[Ag(NH_3)_2]$+, $[Ag(CN)_2]^-$, $[Ni(CN)_4]^{n-}$ (n=2 and 4), $[Cu(NH3)4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[MnO_4]^-$, $[Fe(CN)_6]^{n-}$ (n=3 and 4), $[FeF_6]^{3-}$, $[Fe(H_2O)_6]^{3+}$, $[Fe(C_2O_4)_3]^3$-, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^3$+, $[Ni(NH_3)_6]^{2+}$, $[PbCl_6]^{2-}$ (iv) Stability Constant of Transition Metal complexes and Chelate effect (v) Various types of isomerism, viz., hydrate, ionisation, linkage, polymerization and coordination position. Stereoisomerism in C.N.-4 and C.N.-6 (only $ML_4L'_2$ and $ML_3L'_3$ complexes).
Block 2	
Unit IV	**Chemistry of Lanthanides and Actinides** i. Electronic Configuration, ii. Atomic, Ionic radii and Lanthanide Contraction. iii. Ionisation energy , iv. Calculation of magnetic moments and correlation with experimental data (specially for lanthanides), v. Colour and spectral behaviour, vi. Oxidation states and their stability, vii. Ability to form complexes and examples of complexes of different coordination numbers. viii. Occurrence and principle of separation of lanthanides. ix. Chemistry of separation of Np, Pu and Am from U and x. One synthesis each of Np to Lr.
Unit V	**Chemistry of Nobel Gases** Properties, Occurrence, Isolations and Applications. Chemistry of Noble Gases, Compounds of Xenon & Krypton and their reactions. Clathrates.
Unit VI	**Acid - Base and Non-aqueous solvents** **Acid - Base concept -**Lewis concept, Concept and classification of hard and soft acids and bases. Applications of HSAB principle. **Non-aqueous solvents-**Classification and characteristic properties of solvents. Types of chemical reactions occurring in liquid ammonia (NH_3) and liquid sulphur dioxide (SO_2).
Suggested Text Book Readings: Text Books (Theory Courses): a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd. b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal. c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication. d. Chemistry for degree students, R. L. Madan Reference Books: a. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd. b. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford. c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley. d. Concepts of Models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley. e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley. f. Inorganic Chemistry, A.G. Sharpe, ELBS g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.	

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer: Attempt all courses

1. Symmetry and Group Theory , Prof. Anindya Datta NPTEL , https://onlinecourses.nptel.ac.in/noc22_cy40/preview
2. Transition Metal Organometallic Chemistry: Principles To Applications , Prof. P. Ghosh , NPTEL https://onlinecourses.nptel.ac.in/noc22_cy39/preview
3. Advanced Transition Metal , Prof. M S Balakrishna , NPTEL https://onlinecourses.nptel.ac.in/noc22_cy60/preview
4. Chemistry of d-block elements, Quantum Chemistry and Spectroscopy, Dr. Niraj Upadhyay , Dr. Harisingh Gour Vishwavidyalaya, Sagar https://onlinecourses.swayam2.ac.in/cec22_cy05/preview

Electronic media and other digital components in the curriculum:
Choose any one or more than:(Electronic Media: Audio/Video Lectures, Online Counselling/Virtual Classes/E-Contents/e-SLM/OER/supplementary links for reference/Video Conferencing/Radio broadcast/Web Conferencing/ Other electronic and digital contents**)**

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:2</td><td>Semester:3</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: SBSCHE-01N</td><td colspan="2">Course Title: ORGANIC CHEMISTRY II (ADVANCE ORGANIC CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
To provide knowledge about preparation and chemical reactions of Alcohols and Epoxides - Alcohols Dihydric alcohols: (Ethylene Glycol)
To provide basic knowledge about the order of reactivity of different carboxylic acid derivatives and the reactivity of different carboxylic acid derivatives.
To provide knowledge about mechanism of named reactions of carbonyl compounds and condensation reactions as well as their use in food and pharmaceuticals.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1 The preparation and chemical reactions of Alcohols and Epoxides - Alcohols Dihydric alcohols: (Ethylene Glycol)
CO-2 Understanding the order of reactivity of different carboxylic acid derivatives and the reactivity of different carboxylic acid derivatives.
CO-3 Able to recognize structures of acid halides, esters, amides, acid anhydrides.
CO-4 Able to write down structure of phenol and phenoxide ion and chemical reactions of phenols.
CO-5 Know the mechanism of named reactions of carbonyl compounds and condensation reactions as well as their use in food and pharmaceuticals.</td></tr>
<tr><td colspan="2">Credits:4</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Max. Marks: 100</td><td>Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Electromagnetic Absorption Spectra
Electromagnetic Radiations, Electromagnetic spectrum and absorption of radiations. The Absorption Laws. UV-Visible spectrophotometer, formation of Absorption Band. Chromatophore Concept, Calculation of Absorption Maximum. Infra Red Spectroscopy Fundamental and Applications.</td></tr>
<tr><td>Unit II</td><td colspan="2">Alcohols and Phenols
Classification and nomenclature. Monohydric alcohols – nomenclature, methods of formation by reduction of aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols – nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacolo-pinacolone rearrangement. Trihydric alcohols – nomenclature and methods of formation, chemical reactions of glycerol.
Phenols
Nomenclature, structure and bonding, Preparation of 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. Mechanisms of Fries</td></tr>
</table>

	rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer- Tiemann reaction.
Unit III	**Ethers and Epoxide** **Ethers** Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Williamson's synthesis, formation and cleavage of oxonium salts, elementary idea about crown ethers. **Epoxides** Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.
Block 2	
Unit IV	**Aldehydes and Ketones** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of alkedydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties. Mechnism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, 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 alkehydes and ketones.
Unit V	**Carboxylic Acids and Derivatives** Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Synthesis of acid chlorides, esters and amides. 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 formation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents. **Carboxylic Acid Derivatives** Structure and nomenclature of acid chlorides, esters, amides(urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).
Unit VI	**Organic Compounds of Nitrogen** Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural

	features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

Suggested Text Book Readings:
a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
b) Organic Chemistry, L.G. Wade Jr. Prentice Hall
c) Fundamentals of Organic Chemistry Solomons, John Wiley.
d) Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
g) Organic Chemistry, Vol. I, II, I.L. Finar
h) Spectrometric Identification of organic compounds. Robert M. Silverstein, Clayton G. Bassler, Terence C. Morril, John Wiley.

Suggested online links:
http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/105/104105124/
https://nptel.ac.in/courses/103/106/105106204/
https://nptel.ac.in/courses/104/105/104105034/
https://nptel.ac.in/courses/104/103/104103121/
https://nptel.ac.in/courses/104/102/104102016/
https://nptel.ac.in/courses/104/106/104106106/
https://nptel.ac.in/courses/104/105/104105120/

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer:

1. **Organic Chemistry-1, Dr. B. S. Balaji,** Jawaharlal Nehru University, https://onlinecourses.swayam2.ac.in/cec22_cy06/preview
2. **Reagents In Organic Synthesis, Prof. Subhas Chandra Pan, https://onlinecourses.nptel.ac.in/noc22_cy55/preview**
3. **Introductory Organic Chemistry II, Prof. Neeraja DashaputreProf. Harinath Chakrapani, https://onlinecourses.nptel.ac.in/noc22_cy46/preview**

Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year: 3</td><td>Semester:5</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: DCECHE -105N</td><td colspan="2">Course Title: PHYSICAL CHEMISTRY II (ADVANCE PHYSICAL CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
To undersand basic knowledge about first law and second law of thermodynamics, thermochemistry, entropy enthalpy etc.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1- After the completion of the semester, student will acquire knowledge of first law and second law of thermodynamics, thermochemistry, entropy enthalpy etc.
CO-2- It will also make them familiar with conductance, equivalent conductance, Kohlrausch’s law, Ostwald dilution law, Deby-Huckel Onsagar equation, e.m.f. of cell, types of cell, liquid junction potential, pH and pka, Henderson- Hazel equation etc.</td></tr>
<tr><td colspan="2">Credits: 2</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Category of Course(Please mention category of course; It may have more than one option)</td><td>employability/ skill development/</td></tr>
<tr><td colspan="2">Max. Marks: 100</td><td>Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Chemical Equilibrium and Phase Equlibrium
Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chattelier's principle.
Phase Equilibrium
Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system - water, Sulpher and Hellium. First and second order phase transitions. Phase equilibria of two component systems - solid-liquid equilibria, simple eutectic - Pb-Ag system, desilverisation of lead, Systems involving compound formation with a congruent melting point (Mg-Zn) and an incongruent melting point (CuSO4-H2O). Nernst distribution law and its thermodynamic derivation</td></tr>
<tr><td>Unit II</td><td colspan="2">Thermodynamics –II
Second law of thermodynamics: concept of entropy, entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical process.
Gibbs and Helmholtz functions; Criteria for thermodynamic equilibrium and spontaneity in term of changes in entropy, Gibbs and Helmholtz functions. Concept of chemical potential.</td></tr>
<tr><td>Unit III</td><td colspan="2">Electrochemistry – II
Types of reversible electrodes - gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode-reference</td></tr>
</table>

	electrodes-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. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K). Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations. Definition of pH and pKa determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods. **Buffers -** mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts. Electrochemical corrosion and its prevention.
Block 2	
Unit IV	**Colloidal State and Macromolecules** Definition of colloids and classification of colloids. Donnan membrane theory and its application. Electrokinetic Potential (Zeta potential). **Solids in liquids (sols):** properties - kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. **Liquids in liquids (emulsions**): types of emulsions, preparation, Emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids. **Macromolecules :** Determination of molecular weight of macromolecules by osmotic pressure and viscosity methods. Concepts of micelles and critical micelle concentrations. A brief introduction to conducting and light emitting polymers.
Unit V	**Surface Phenomenon** **Surface Chemistry** Adsorption, difference between Physical adsorption and chemisorption, Adsorption isotherms - Langmuir adsorption isotherm and Freundlich adsorption isotherm, Gibbs adsorption equation, BET equation, Determination of surface area.
Unit VI	**Physical Properties and Chemical Constitution** Molar volume, Parachor Molar refraction and Polarisation, Dipolemoment, Debey equation (derivation not required) and Clausius-Mosotti equation.
Suggested Text Book Readings: a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill. b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd. c. The Elements of Physical Chemistry, P.W. Atkins, Oxford. d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd. e. Graduate physical Chemistry, Volume I-III By L.R. Sharma and M.S. Pathania f. Principles of Physical Chemistry by B.R. Puri, L.P Sharma and M.S. Pathania, Vishal publication, Jalandhar. **Suggestive digital platforms web links** 1. https://www.coursera.org/courses?query=chemistry&languages=en 2. https://www.mooc-list.com/tags/physical-chemistry 3. https://www.coursera.org/learn/physical-chemistry	

4. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/
5. http://heecontent.upsdc.gov.in/Home.aspx
6. https://nptel.ac.in/courses/104/108/104108078/
7. https://nptel.ac.in/courses/104/108/104108124/
8. https://nptel.ac.in/courses/104/106/104106122/

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer:

1. **Chemistry and Physics of Surfaces and Interfaces, Prof. Thiruvancheril G. Gopakumar, NPTEL, https://onlinecourses.nptel.ac.in/noc22_cy57/preview**
2. **Introduction to Chemical Thermodynamics and Kinetics, Prof. Arijit Kumar De, NPTEL, https://onlinecourses.nptel.ac.in/noc22_cy58/preview**

Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2021

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:3</td><td>Semester:5</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: DCECHE -106</td><td colspan="2">Course Title: INORGANIC CHEMISTRY III (SELECTED TOPICS IN INORGANIC CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
• To provide basic knowledge about chemistry of transition and inner-transition elements, Concepts of coordination chemistry and their applications
• To provide basic knowledge about importance of different acid-base concepts.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1 Chemistry of transition and inner-transition elements. These insights are important as they help in the rational selection of the cations of these elements for tailor-made syntheses of newer complexes
CO-2 Concepts of coordination chemistry and their applications
CO-3 Importance of different acid-base concepts which forms the basis of rational ligand designing and coordination complex formation for specific bioinorganic, materials and optoelectronic applications.
CO-4 Importance and different chemical aspects of non-aqueous solvents which now-a-days are gaining importance in varied targeted syntheses of drugs and materials for technological applications</td></tr>
<tr><td colspan="2">Credits: 2</td><td>Type of Course: Elective</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Metal-ligand Bonding in Transition Metal Complexes
Limitations of valance bond theory, an elementary idea of crystal field theory, Crystal Field Stabilization Energy (CFSE), crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.
Thermodynamic and Kinetic Aspects of Metal Complexes
A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes and trans effect.</td></tr>
<tr><td>Unit II</td><td colspan="2">Magnetic and Electronic spectra of Transition Metal Complexes
(a) Electronic spectra of Transition Metal Complexes
Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.
(b) Magnetic Properties of Transition Metal Complexes
Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.</td></tr>
<tr><td>Unit III</td><td colspan="2">Organometallic Chemistry
Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and catalytic applications of alkyls and aryls of Li, Al, Hg, Sn.</td></tr>
<tr><td>Block 2</td><td colspan="2"></td></tr>
</table>

Unit IV	**Metal Carbonyls and Nitrosyls** **(a) Metal Carbonyls :** Ligand behaviour of CO, General methods of preparation, 18 electron rule, nature of bonding (Synergic effect) in the mononuclear carbonyls, Representation of structures of the binary carbonyls of all nuclearities of V, Cr, Mn, Fe, Co and Ni. **(b) Metal Nitrosyls :** Ligand behaviour of NO (NO^+, NO^- and bridging NO), preparation and structures of nitrosyls of Cr, Fe and Ru; carbonyl nitrosyls and cyano nitrosyls
Unit V	**Inorganic Polymers** **Silicones and Phosphazenes** Silicons and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.
Unit VI	**Inorganic Biochemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to oxygen carrieres hemoglobin chemistry and myoglobin. Vitamin B-12, Nitogenase and Chlorophyll structure and applications. Biological role of alkali and alkaline earth metal ions with special reference to Na^+, K^+ and Ca^{2+}.
Unit VII	**Environmental Chemistry and Green Chemistry** (a) **Environmental Chemistry** :The earth's atmosphere and its components, Lapse rate, Types of pollutants and their sources (in water, Air and Soil). Green house effect and global warming. Acid rains, Ozone layer (Importance and its protection). **(b) Green Chemistry** Principles and concept of green chemistry, atom economic and noneconomic reactions, reducing toxicity, a few examples of environmental friendly reactions and reaction media.
Unit VIII	**Metal and Metallurgy** General principles of extraction and purification of metals. Occurrence and isolation of elements, Extraction and isolation of Metals (Y, La, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, Re, Fe, Co, Ni and platinum) from their minerals.

Suggested Text Book Readings:

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.

b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.

c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.

d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard
L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.

b. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.

c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.

d. Concepts of Models of Inorganic Chemistry, B. Douglas, D.
Mc Daniel and J Alexander, John Wiley.

e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.

f. Inorganic Chemistry, A.G. Sharpe, ELBS

g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

Suggestive digital platforms web links:

https://swayam.gov.in/

https://www.coursera.org/learn/physical-chemistry https://www.mooc-list.com/tags/physical-chemistry https://www.openlearning.com/courses/introduction-to-physical-chemistry/ https://www.my-mooc.com/en/categorie/chemistry https://onlinecourses.swayam2.ac.in/nce19_sc15/preview https://www.coursera.org/browse/physical-science-and-engineering/chemistry
This course can be opted as an elective by the students of following subjects:
Suggested equivalent online courses (MOOCs) for credit transfer:
Electronic media and other digital components in the curriculum: **Choose any one or more than:**e-SLM/Other electronic and digital contents

Name of electronic media: e-SLM	Year of incorporation: 2022

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:3</td><td>Semester:6</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: DCECHE -108</td><td colspan="2">Course Title: ORGANIC CHEMISTRY III (SELECTED TOPICS IN ORGANIC CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives: This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO1: To gain knowledge about qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules.
CO2: To provide knowledge about Organometallic Compounds, Sulphur Containing Compounds and NMR Spectroscopy.</td></tr>
<tr><td colspan="2">Credits:2</td><td>Type of Course: Elective</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">NMR (PMR) 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 structures elucidation of simple organic compounds using UV, IR and 1H NMR spectroscopic techniques.</td></tr>
<tr><td>Unit II</td><td colspan="2">Organometallic Compounds
Organomagnesium compounds: the Grignard reagents, formation, structure and Chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.</td></tr>
<tr><td>Unit III</td><td colspan="2">Sulphur Containing Compounds
Nomenclature, structural formation, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides & Sulphaguamidine.</td></tr>
<tr><td>Block 2</td><td colspan="2"></td></tr>
<tr><td>Unit IV</td><td colspan="2">Amino Acids, Peptides, Proteins and Nucleic Acids
Classification, structure and stereochemistry of amino acids. Acid-base behaviour, Isoelectric point and electrophoresis, Preparation and reactions of α–amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins, Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure, Protein denaturation/renaturation.
Nucleic acids: Introduction. Constituents of ncleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.</td></tr>
<tr><td>Unit V</td><td colspan="2">Active Methylene Group</td></tr>
</table>

	Preparation and synthetic applications of ethyl acetoacetate and diethyl malonate, Tautomerism.
Unit VI	**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. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. Structures of ribose and deoxyribose. An introduction to disaccarides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.
Unit VII	Problem based on Spectroscopy (UV-Vis., IR and PMR)

Suggested Text Book Readings:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson
(2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education.
3. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
4. Vogel, A.I. A Textbook of Quantitative Analysis, ELBS. 1986
5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry,Universities Pres
7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,

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

This course can be opted as an elective by the students of following subjects:

Suggested equivalent online courses (MOOCs) for credit transfer: Attempt all courses

1. **Application of Spectroscopic Methods in Molecular Structure Determination, Prof. S. Sankararaman, https://onlinecourses.nptel.ac.in/noc22_cy45/preview**
2. **NMR spectroscopy, Prof. R. V Hosur, https://onlinecourses.nptel.ac.in/noc22_cy59/preview**
3. **Organic Chemistry In Biology, Prof. Amit Basak, https://onlinecourses.nptel.ac.in/noc22_cy62/preview**

Electronic media and other digital components in the curriculum:
Choose any one or more than: e-SLM/ Other electronic and digital contents

Name of electronic media: 2022	Year of incorporation: 2022

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:3</td><td>Semester:6</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: DCECHE -109</td><td colspan="2">Course Title: PHYSICAL CHEMISTRY III (SELECTED TOPICS IN PHYSICAL CHEMISTRY)</td></tr>
<tr><td colspan="3">Course Objectives:
• To provide knowledge about Quantum mechanics as well as of spectroscopy with comprehensive understanding of valence bond model and molecular orbital model.
• To provide knowledge about Ultraviolet absorption spectroscopy, Vibrational, Rotational and Electronic Spectroscopy, Infrared spectroscopy and Bioenergetics</td></tr>
<tr><td colspan="3">Course Outcomes:
CO-1 Quantum mechanics as well as of spectroscopy. They will have comprehensive understanding of valence bond model and molecular orbital model.
CO-2 Ultraviolet absorption spectroscopy, Beer Lambert Law, types of electronic transitions and the effect of conjugation and concept of chromophore and auxochrome.
CO-3 Vibrational, Rotational and Electronic Spectroscopy of simple molecule.
CO-4 Infrared spectroscopy in which characteristic absorptions of various functional groups.
CO-5 Bioenergetics-Gibbs and Helmholtz energies with special emphasis on biological applications</td></tr>
<tr><td colspan="2">Credits:2</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Category of Course</td><td>value-added / employability</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td colspan="3">(Syllabi should be framed block wise/unit wise; No of blocks and units may change)</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">Elementary Quantum Mechanics
Black-body radiation, Planck’s radiation law, photoelectric effect, heat capacity of solids, Bohr’s model of hydrogen atom (no derivation) and its defects, Compton effect. de Broglie’s hypothesis, the Heisenberg’s uncertainty principle, Hamiltonian operator. Statement of the Born- Oppenheimer approximation, degrees of freedom.</td></tr>
<tr><td>Unit II</td><td colspan="2">Molecular Statistics
The Boltzmann distribution. Maxwell distribution law for distribution of molecular speeds. The Maxwell-Boltzmann distribution law for the distribution of molecular energies. The partition functions. Thermodynamic quantities from partition functions. The Sackur-Tetrode equation for molar entropy of monatomic gases. Rotational and vibrational partition functions. The characteristic temperature. The calculation of Gibbs free energy changes and equilibrium constant in terms of partition functions.</td></tr>
<tr><td>Unit III</td><td colspan="2">Laws of Photochemistry
Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, nonradiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples).</td></tr>
</table>

Block 2	
Unit IV	**Vibrational, Rotational and Electronic Spectroscopy** **Rotational Spectrum:** Diatomic molecules: Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect. **Vibrational Spectrum:** *Infrared spectrum*: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of of different functional groups. **Raman Spectrum**: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. **Electronic Spectrum**: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. **Qualitative description of σ, π-** and n M.O., their energy levels and the respective transitions.
Unit V	**Nuclear Chemistry** Nuclear reactions: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy. Nuclear reactor: the natural uranium reactor, classification of reactors, breeder reactor. Nuclear fusion and stellar energy. **Radiation chemistry:** Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rcm, Sievert).
Unit VI	**Bioenergetics** Gibbs and Helmholtz energies with special emphasis on biological applications: study of energy transformations in living systems (bioenergetics): standard state in biochemistry, ATP-the currency of energy, Glycolysis, limitation of applicability of thermodynamics in biology.
Suggested Text Book Readings: 1. Skoog .D.A., West. D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010). 2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988) Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University 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	
This course can be opted as an elective by the students of following subjects:	

Suggested equivalent online courses (MOOCs) for credit transfer: 1. **Quantum Chemistry of Atoms and Molecules, Prof. Anindya Datta, https://onlinecourses.nptel.ac.in/noc22_cy41/preview**	
Electronic media and other digital components in the curriculum: **Choose any one or more than:**e-SLM/ Other electronic and digital contents	
Name of electronic media: e-SLM	Year of incorporation: 2022

Syllabus for [B.Sc.]: Subject: [Chemistry]

<table>
<tr><td colspan="3">Course prerequisites: Chemistry in 10+2 Level</td></tr>
<tr><td>Programme: B.Sc.</td><td>Year:3</td><td>Semester: 6th</td></tr>
<tr><td colspan="3">Subject: Chemistry</td></tr>
<tr><td>Course Code: SBSCHE-02N</td><td colspan="2">Course Title: ADVANCED ANALYTICAL TECHNIQUES</td></tr>
<tr><td colspan="3">Course Objectives:
• To provide knowledge about Statistical Analysis
• To provide basic knowledge about Volumetric analysis, Gravimetric analysis and Separation techniques.
• To provide basic knowledge about Nano Chemistry.</td></tr>
<tr><td colspan="3">Course Outcomes:
CO1: To gain knowledge about Statistical Analysis
CO2: To gain basic knowledge about Volumetric analysis, Gravimetric analysis and Separation techniques and about basic knowledge of Nano Chemistry.</td></tr>
<tr><td colspan="2">Credits:4</td><td>Type of Course: Core</td></tr>
<tr><td colspan="2">Category of Course</td><td>value-added / employability/</td></tr>
<tr><td>Max. Marks: 100</td><td colspan="2">Min. Passing Marks: 36</td></tr>
<tr><td colspan="3">(Syllabi should be framed block wise/unit wise; No of blocks and units may change)</td></tr>
<tr><td>Block 1</td><td colspan="2"></td></tr>
<tr><td>Unit I</td><td colspan="2">BLOCK-1
Unit 1: Statistical Analysis
Definition of terms mean and median, precision, standard deviation, relative standard deviation, accuracy, absolute error, types of error in experimental data, determinate (systematic), indeterminate (or random) and gross, sources of errors and effects upon the analytical results, methods for reporting analytical data, statistical evaluation of data, indeterminate errors, uses of statistics.</td></tr>
<tr><td>Unit II</td><td colspan="2">Unit 2: Volumetric analysis
General principles of acid – base titration, precipitation titration, oxidation-reduction titration, iodimetry and iodometry, complexometric titrations, use of EDTA for the determination of Ca2+ and Mg2+ and hardness of water, types of EDTA titrations, metal ion indicators.</td></tr>
<tr><td>Unit III</td><td colspan="2">Unit 3: Gravimetric analysis
Precipitation from homogeneous medium, purity of precipitates, co-precipitation, post- precipitation, washing and ignition of precipitates, contamination and their removal.</td></tr>
<tr><td>Block 2</td><td colspan="2"></td></tr>
<tr><td>Unit IV</td><td colspan="2">Unit 4: Separation techniques
Principle, technique and analytical applications of the following:
(a) Solvent extraction
(b) Chromatography (Paper, Thin Layer, Column and HPLC)
(c) Ion exchange</td></tr>
</table>

Unit V	Unit 5: Nano Chemistry Nanomaterials – An Introduction, Size Effects, Defining Nanodimensional Materials, Potential Uses for Nanodimensional Materials, The General Methods Available for theSynthesis of Nanodimensional Materials, Precipitative Methods, Reactive Methods in High Boiling Point Solvents, Hydrothermal and Solvothermal Methods, Gas-Phase Synthesis of Semiconductor Nanoparticles, Synthesis in a Structured Medium, The Suitability of Such Methods for Scaling, Conclusions and Perspectives on the Future, Oxide Nanoparticles, Nanotubes and Nanowires. Study of different characterization tools (XRD, TEM, SEM, AFM, etc.) for Nanomaterials.
Suggested Text Book Readings: 1. Skoog .D.A., West. D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010). 2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988) Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University 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	
This course can be opted as an elective by the students of following subjects:	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	
Electronic media and other digital components in the curriculum: **Choose any one or more than:**e-SLM/ / Other electronic and digital contents	
Name of electronic media: e-SLM	Year of incorporation 2022