



DEPARTMENT OF CHEMISTRY
EVALUATION SCHEME OF UG & PG PROGRAM AS PER NEP-2024-25

w.e.f. July, 2024-25

Certificate in Bioorganic and Chemical Analysis

1st Year / 1st Semester



S. No.	Course Code	Course Title	(T)Theory (P) Practical	Course Type	Periods per Week			Evaluation Scheme			End Semester	Subject Total	Total Credit	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture	Tutorial	Practical	Class Test	Teacher Assessment	Total				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Values	Professional Ethics	
1.	B020101T/CH151	Fundamentals of Chemistry-I	T	Core Major	3	1	-	15	10	25	75	100	04	√		√					-
2.	B020102T/CH152	Fundamentals of Chemistry-II	T		3	1	-	15	10	25	75	100	04	√		√					-
3.	B020103P/CH153	Quantitative Measurement	P		-	-	4	15	10	25	75	100	02	√	√	√					
4.	B020104P/CH154	Analytical Testing	P		-	-	4	15	10	25	75	100	02	√	√	√					
5.	B000101V/CH137	Plastic Waste Management	T + P	Vocational	1	-	2	-	-	-	100	100	03	√	√	√		√			
6.	Z010101T/BE105	Food Nutrition and Hygiene	T	Co-curricular	2	-	-	15	10	25	75	100	02	√		√		√			
7.	A050101T/HM101	Rashtra Gaurav*	T	Audit Course	2	-	-	-	-	-	100	100	00					√	√	√	
TOTAL					11	02	10	75	50	125	575	700	17								

*Qualifying (Non-Credit Course)

Effective from Session: 2024-2025

Course Code	B020101T/CH151	Title of the Course	Fundamentals of Chemistry-I	L	T	P	C
Year	First	Semester	First	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The main aim of this course is to impart fundamental knowledge of chemical bonding, and periodic properties and their trends, across the periodic table. The course would enable the learner to predict and element's properties by comprehension of the properties of different periods and groups. The learner would also understand the concepts of stereochemistry, organic reaction mechanisms, and other fundamentals of organic chemistry.						

Course Outcomes	
CO1	The students would perceive a sound knowledge of molecular polarity and weak chemical forces such as van der Waals forces, ion-dipole forces, and dipole-dipole interactions and induced dipole interaction. They would also be acquainted with current bonding models taking examples of simple inorganic and organic molecules to predict their structures and important bonding parameters.
CO2	The students would get an acumen related to the periodic as an invaluable tool for properties prediction. A detailed insight of the periodic table will be imparted.
CO3	The students would be able to evaluate the fundamentals of chemical reaction, reactive intermediates, transition states and other elements related to bond formation. The student would be able to understand the reactants, catalysts, stereochemistry, and the formation of major and minor products in organic reactions.
CO4	The students would perceive a sound knowledge of stereochemistry and two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.
CO5	The students would learn about solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, and osmosis and their principles and applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Molecular polarity	van der Waals forces, ion-dipole forces, dipole dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability. Fajan's rules and consequences of polarization.	8	1
2	General Periodic Properties	Electronic configurations of elements, types of radii (covalent, crystal and Vander Waal's radii), electron affinity, electronegativity, and ionization potential. Pauling scale, Mulliken electronegativity scale, Slater rules, Allred and Rochow scale, diagonal relationship.	8	2
3	Periodic properties of Atoms (with reference to s & p-block)	Brief discussion, factors affecting and variation trends of following properties in groups and periods (with reference to s & p-block) such as effective nuclear charge, shielding or screening effect, Atomic and ionic radii, Electronegativity, Ionization enthalpy, Electron gain enthalpy.	8	2
4	Mechanism of Organic Reactions	Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents electrophiles and nucleophiles.	6	3
5	Essentials of Isomerism	Concept of isomerism, Different types of isomerism, their nomenclature and associated physico chemical properties. Structural isomerism: chain isomerism, positional isomerism, functional isomerism and metamerism, keto-enol tautomerism.	6	3
6	Stereochemistry-I	Optical isomerism: elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomer, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.	8	4
7	Stereochemistry-II	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.	8	4
8	Solutions and Colligative Properties	Dilute Solutions, Colligative Properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis - laws of osmotic pressure, its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point. Derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.	8	5

Reference Books:

Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
 Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
 Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
 Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
 Mukeherji, Singh, Kapoor, Organic Chemistry, Vol 1, New Age International 2014

e-Learning Source:

<http://heecontent.upsdc.gov.in/Home.aspx>
<https://nptel.ac.in/courses/104/106/104106096/>
<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>

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	-	3	-	-	2	3
CO2	2	1	-	-	-	-	-	2	-	-	2	2
CO3	1	3	-	-	-	-	-	3	-	-	3	3
CO4	3	2	-	-	-	-	-	2	-	-	2	3
CO5	2	3	-	-	-	-	-	2	-	-	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B020103T/CH152	Title of the Course	Fundamentals of Chemistry-II	L	T	P	C
Year	First	Semester	First	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The objective of this course is to provide fundamental and essential knowledge on the origin of chemistry, ancient Indian chemistry, principles of chemical calculations, weak chemical forces, classical and contemporary atomic structure theories, as well as thermodynamics, chemical equilibrium, and acids, and bases. Upon completion of this course, students would gain a thorough understanding of chemical forces, molecular polarity, periodic properties, and trends which will assist in the prediction of chemical forces, classical and modern atomic structure theories, as well as thermodynamics and the principles of chemical equilibrium for acids and bases.						

Course Outcomes	
CO1	The students would perceive a sound knowledge of fundamental and essential knowledge on the origins of chemistry, ancient Indian chemistry, principles of chemical calculations, and weak chemical forces.
CO2	The students would understand the concept of matter waves and de-Broglie equation, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, Ψ and Ψ^2 significance, quantum numbers, radial and angular wave functions, probability distribution curves, shapes of s, p, d orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rule, electronic configurations of the elements, and effective nuclear charge.
CO3	The students would understand the fundamentals of valence bond theory, valence shell electron pair repulsion (VSEPR) theory, molecular orbital theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy
CO4	The students would analyze the ionic structures, radius ratio rule and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rules and their applications.
CO5	The students would know about the different concepts of acids and bases and theories of indicators like acid-base, redox, metal ion, adsorption, and choice of indicators. They would also evaluate types of systems, intensive and extensive properties, thermodynamic processes, and laws.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	The beginnings of chemistry	The history of chemistry, quantitative experiments by Lavoisier, Proust, and Dalton, the law of conservation of mass, and the law of multiple proportions. Avogadro's hypothesis. Introduction of ancient Indian chemistry, contribution of Indian chemists in context to the holistic development of modern science and technology.	8	1
2	Fundamentals of Chemical Calculations and Weak Chemical Forces	Atomic weight, molecular weight, equivalent weight, mole concept, percentage yield, composition of liquid mixtures and gaseous mixtures, molarity, molality, normality. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	8	1
3	Structure and Bonding	Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and Ψ^2 , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rule, electronic configurations of the elements, effective nuclear charge.	8	2
4	Chemical Bonding-I	Covalent Bond: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2^- and H_2O , MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, Percentage ionic character from dipole moment and electro-negativity difference.	6	3
5	Chemical Bonding-II	Ionic Solids: Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule, Metallic bond-free electron, valence bond and band theories.	8	3
6	Recapitulation of Basics of Organic Chemistry	Bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications. Types of organic reactions, Energy considerations. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	8	4
7	Acids and Bases	Lowery - Bronsted concept, Lewis's concept, hard and soft acids and bases, Lux - Flood acids and bases, theories of indicators, acid-base, redox, metal ion and adsorption indicators and choice of indicators.	6	4
8	Thermodynamics and Chemical Equilibrium	System, surroundings etc. Types of systems, intensive and extensive properties, State and path functions and their differentials, Thermodynamic processes, concept of heat and work. Thermodynamic laws, enthalpy changes, entropy, processes and functions, free energy, partial molar quantities, activity, activity co-efficient, and fugacity, effect of temperature and pressure on equilibrium constants in gaseous system.	8	5

Reference Books:

Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010

Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.

Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.

Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.

e-Learning Source:

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

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<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>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	-	3	-	-	2	3
CO2	2	1	-	-	-	-	-	2	-	-	2	2
CO3	1	3	-	-	-	-	-	3	-	-	3	3
CO4	3	2	-	-	-	-	-	2	-	-	2	3
CO5	2	3	-	-	-	-	-	2	-	-	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Effective from Session: 2024-2025

Course Code	B020103P/CH153	Title of the Course	Quantitative Measurement	L	T	P	C
Year	First	Semester	First	0	0	4	2
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The chemistry lab program for this course is designed to with an objective to impart the essential knowledge about different laboratory techniques and tests for the estimation of metal ions, concentrations of acids and alkalis in commercial products, and estimation of the potability of water sample.						

Course Outcomes	
CO1	The students would be able to prepare standard solutions of different concentrations.
CO2	The students would understand and be able to perform the potability tests of water samples.
CO3	The students would be able to estimate different metals ions.
CO4	The students would be able to estimate alkali and acid contents in an unknown sample.
CO5	The students would develop skills to understand the laboratory methods and tests related to the estimation of metals ions, acids and alkali contents in commercial products.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Preparation of Standard Solutions	Preparation of standard solution of $K_2Cr_2O_7$. To find out the concentration of unknown $K_2Cr_2O_7$ solution using $Na_2S_2O_3$ solution as an intermediate. Preparation of standard solution of copper sulphate. To find out the concentration of unknown copper sulphate solution using $Na_2S_2O_3$ solution as an intermediate.	15	5
2	Estimation of Metals Ions	Estimation of ferrous and ferric by dichromate method. Estimation of copper using thiosulphate.	15	2,3
3	Estimation of Acids and Alkali Contents	Determination of acetic acid in commercial vinegar using NaOH. Determination of alkali content – antacid tablet using HCl. Estimation of oxalic acid by titrating it with $KMnO_4$.	15	2,4
4	Estimation of one Anion and Cation	Estimation of one anion and cation in each salt: Anion: CO_3^{2-} , S^{2-} , SO_3^{2-} , SO_4^{2-} , NO_3^- , NO_2^- , Cl^- , Br^- , I^- , PO_4^{3-} , CO_3^{2-} , CH_3COO^- Cation: Pb^{2+} , Cu^{2+} , As^{3+} , Al^{3+} , Fe^{3+} , Mn^{2+} , Ni^{2+} , Zn^{2+} , Co^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+} , NH_4^+	15	1,2

Reference Books:

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

e-Learning Source:

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

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	-	-	-	-	-	-	2	1	-	-
CO2	2	1	-	-	-	-	-	-	3	2	-	-
CO3	2	2	-	-	-	-	-	-	2	1	-	-
CO4	1	3	-	-	-	-	-	-	1	2	-	-
CO5	3	1	-	-	-	-	-	-	3	2	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B1020104P/CH154	Title of the Course	Analytical Testing	L	T	P	C
Year	First	Semester	First	0	0	4	2
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The objective of the chemistry lab program in this course is to provide essential knowledge of good laboratory practice (GLP), calibration of apparatuses, preparation of standard solutions of various concentrations, determination of viscosity, surface tension of liquids, and simple laboratory techniques.						

Course Outcomes

CO1	The students would be able to understand and follow good laboratory practice (GLP).
CO2	The students would be able to understand the basic analytical and technical skills in different fields of chemistry.
CO3	The students would know the record keeping and maintenance of lab record.
CO4	The students would be able to estimate the composition and constituents of inorganic salts and hydrated water in samples.
CO5	The students would be able to determine the viscosity and surface tension of liquids.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Good Laboratory Practices (GLP)	Good laboratory practices, Calibration of thermometer and burette	15	1,2,3
2	Simple Laboratory Techniques	Crystallization, fractional crystallization, distillation, fractional distillation, melting point and boiling point determination.	15	2,3
3	Inorganic Salts and Hydrated Water	Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. Estimation of calcium content in chalk as calcium oxalate by permanganometry. Estimation of water of crystallization in Mohr's salt by titrating with KMnO ₄ .	15	2,5
4	Viscosity and Surface Tension of Liquids	Determination of relative viscosity of a liquid with water and determination of % composition of an unknown solution. Determination of the surface tension of an organic liquid and determination of % composition of an unknown mixture.	15	4

Reference Books:

Saxena Ruchi, Srivastava Alok Kumar, "Read & Do Practical Chemistry", Kitab Mahal, New Delhi, India (2016).
 Skoog D. A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia (2010).
 G. Larry Hargis, "Analytical Chemistry: Principles and Techniques" Pearson© (1988)
 B.Sc. Physics Practical Book By CI Arora

e-Learning Source:

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

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	-	-	-	-	3	2	-	-
CO2	1	2	-	-	-	-	-	-	2	1	-	-
CO3	3	3	-	-	-	-	-	-	3	2	-	-
CO4	3	1	-	-	-	-	-	-	2	3	-	-
CO5	2	2	-	-	-	-	-	-	3	2	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025							
Course Code	B000101V/CH137	Title of the Course	Plastic Waste Management	L	T	P	C
Year	First	Semester	First	1	0	2	3
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	This course's primary goal is to equip students with the fundamental knowledge of how laboratories operate; how to calibrate equipment, how to prepare standard solutions, solutions in a range of concentrations, and how to solve qualitative and quantitative problems both independently and collaboratively associated with the treatment of waste like plastic, pharmaceuticals, agrochemicals, households etc.						

Course Outcomes	
CO1	After completing this course, students will be able to analyses qualitatively, comprehend the fundamentals of treating plastic and industrial waste, and analyses physical parameters of wastes.
CO2	Students would be capable of handling and sampling plastic and industrial waste.
CO3	Understand the handling of radioactive waste and its disposal, conductivity, and its measurements
CO4	Able to conduct and analyses electro-analytical procedures and potentiometric measurements.
CO5	Learning about garbage recycling and sustainability.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Managerial Skill on Waste Treatment/Water Treatment	Theory: Introduction of plastic and its classification; waste focusing on metal deduction. Practical: Qualitative Analysis	10	1,2
2	Supervisory and Technician Skill For Pharma/Chemical Industries	Theory: Sampling and handling of Industrial waste/ plastic waste. Practical: Sampling and digestion	10	1,2
3	Managerial (QA/QC) Skill For Cement/Plastic/Textile Industries /Waste Treatment Plant Industries	Theory: Principles of industrial waste treatment/ plastic waste treatment. Practical: Physical parameters of waste	10	1,2
4	Technician Skill/Radioactive Waste Handling Expertise For Nuclear Power Plant	Theory: Radioactive waste and its disposal, conductivity and its measurements. Practical: Conductivity measurement of different samples	10	1,3
5	Technician Skill For Sugar, Cement, Pharma Steel/Iron Foundries	Theory: Potentiometric measurements, electro analytical methods. Practical: pH measurement & Electrochemical measurements	10	1,4
6	QC Managerial Skill For Cosmetic/Pharma/ Steel/Polymer/ Textile/ Food And Dairy Products	Theory: Sustainability and the chemical industry. Practical: Recycle of wastes	10	1,5

Reference Books:	
Industrial Chemistry by B.K Sharma, By Krishna Publications, GOEL Publishing House	
Environmental Chemistry by H. Kaur, Pragati Prakashan, Meerut.	
Environmental Chemistry by A. K.De , New Age International Publishers, (9th edition)	
Water Pollution by V.P. Kudesia, 4th edition, (latest) Pragati Prakashan, Meerut.	
Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education, sixth edition	
e-Learning Source:	
https://www.researchgate.net/publication/320360474_Metal_Recovery_from_Industrial_and_Mining_Wastewaters	
https://www.routledge.com/Metal-Recovery-from-Industrial-Waste/Brooks/p/book/9781315895352	
https://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf	

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	-	-	-	-	3	2	1	1
CO2	3	3	-	-	-	-	-	-	2	2	2	1
CO3	2	3	-	-	-	-	-	-	3	2	1	1
CO4	3	1	-	-	-	-	-	-	3	2	1	2
CO5	3	3	-	-	-	-	-	-	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025							
Course Code	Z010101T/BE105	Title of the Course	Food, Nutrition and Hygiene	L	T	P	C
Year	First	Semester	First	2	0	0	2
Pre-Requisite	-	Co-requisite	-				
Course Objectives	To learn the basic concept of food, nutrition, hygiene, common diseases prevalent in society along with 1000 days nutrition concept.						

Course Outcomes	
CO1	To learn the basic concept of the Food and Nutrition, and meal planning.
CO2	To learn about macro and micronutrients and its RDA, sources, functions, deficiency, and excess.
CO3	To learn 1000 days Nutrition Concept and study the nutritive requirement during special conditions like pregnancy and lactation.
CO4	To study common health issues in the society and to learn the special requirement of food during common illness.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Concept of Food and Nutrition	(a) Definition of Food, Nutrients, Nutrition, Health, balanced Diet (b) Types of Nutrition- Optimum Nutrition, under Nutrition, Over Nutrition (c) Meal planning- Concept and factors affecting Meal Planning (d) Food groups and functions of food	8	1
2	Nutrients: Macro and Micro RDA, Sources, Functions, Deficiency and excess of	(a) Carbohydrate (b) Fats (c) Protein (d) Minerals Major: Calcium, Phosphorus, Sodium, Potassium Trace: Iron, Iodine, Fluorine, Zinc (e) Vitamins Water soluble vitamins: Vitamin B, C Fat soluble vitamins: Vitamin A, D, E, K (f) Water (g) Dietary Fiber	7	2
3	1000 days Nutrition	(a) Concept, Requirement, Factors affecting growth of child. (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirement and risk factors during pregnancy (c) Breast / Formula Feeding (Birth – 6 months of age) Complementary and Early Diet (6 months – 2 years of age)	8	3
4	Community Health Concept	(a) Causes of common diseases prevalent in the society and Nutrition requirement in the following: Diabetes Hypertension (High Blood Pressure) Obesity Constipation Diarrhea Typhoid (b) National and International Program and Policies for improving Dietary Nutrition. (c) Immunity Boosting Food	7	4

Reference Books:	
Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.	
Sheel Sharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.	
1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf	
https://pediatrics.aappublications.org/content/141/2/e20173716	
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/	
e-Learning Source:	
https://www.udemy.com/course/internationally-accredited-diploma-certificate-in-nutrition	
Diploma in Human Nutrition-Revised Offered by Alison	

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	-	-	2	2	3	2	3	3	2	2	-
CO2	-	-	-	3	2	3	2	3	3	2	2	-
CO3	-	-	-	3	3	2	3	3	-	-	2	-
CO4	-	-	3	3	3	3	3	3	3	2	3	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-25							
Course Code	A050101T/HM101	Title of the Course	RASHTRA GAURAV	L	T	P	C
Year	First	Semester	Second	2	0	0	2
Pre-Requisite	10+2	Co-requisite	None				
Course Objectives	The objective of the course on "Rashtra Gaurav" is to explore and critically analyze the multifaceted dimensions of national pride and glory, as depicted in the paper. Participants will delve into the historical, cultural, social, and political aspects that contribute to the concept of "Rashtra Gaurav" (National Pride) in the context of the specific themes and perspectives presented in the paper. Through in-depth discussions, readings, and interactive sessions, participants will gain a comprehensive understanding of the factors that shape and define a nation's sense of pride, and how these factors influence individual and collective identities. The course aims to foster a nuanced appreciation for the significance of "Rashtra Gaurav" in contemporary society, encouraging participants to critically evaluate its implications and applications within diverse global contexts.						

Course Outcomes	
CO1	To understand the basics of Indian Society and culture.
CO2	To analyze the fundamental issues in India.
CO3	To understand Indian Heritage.
CO4	To examine the philosophical and spiritual developments in India.
CO5	To evaluate the contributions of Major National Characters and Personalities.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	INDIAN SOCIETY & CULTURE	- Unity in Diversity - Art forms, Literature, Culture from Ancient to Modern time. - National and International Awards & Awardees	05	01
2	ISSUES IN INDIA	- Issues of Gender Equality and role of Women Organisations - Issues of Poverty and Development - Social Empowerment through Social Movements in India	05	02
3	INDIAN HERITAGE	- Cultural Heritage in India: Buddhist Monuments at Sanchi, Ajanta & Ellora Caves, Khajuraho, Taj Mahal - Tourist Places in India: Red Fort, Ambar Palace, Kaziranga National Park, Ram Mandir (Ayodhya)	04	03
4	PHILOSOPHICAL AND SPIRITUAL DEVELOPMENTS	- Sufism & Bhakti Movement: Bulleh Shah, Data Ganj Baksh, Khwaja Moinuddin Chishti, and Nizamuddin Auliya. Tulsidas, Surdas, Meera, Nank & Kabir - Jainism: Mahavir's biography and education - Buddhism: The life of Buddha, Contributions of Buddhism to India's Culture	05	04
5	MAJOR NATIONAL CHARACTERS AND PERSONALITIES	- Ashoka the Great and His Dhamma - Raja Ram Mohan Roy & Brahmo Samaj - Savitribai Phule: A Social Reformer and contribution in Women Education - Swami Vivekanand and his philosophies - Mahatma Gandhi: Role of Gandhi in Indian National Movement - Dr. Bhimrao Ambedkar: A Chief architect of the Indian Constitution	06	05

Reference Books:

Jawaharlal Nehru - "The Discovery of India"
 B.R. Ambedkar - "Annihilation of Caste"
 Ramachandra Guha - "India After Gandhi: The History of the World's Largest Democracy"
 Mahatma Gandhi - "My Experiment with Truth"
 S C Dubey- "Indian Society"
 Nadeem Hasnain - "Indian Society and Culture"
 G Shah- "Social Movements in India"

Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	3	2	2	3	2	1	2
CO2	3	2	2	3	1	2	3	1	2	1
CO3	1	2	2	2	2	3	2	3	3	2
CO4	1	3	2	3	2	3	2	3	1	3
CO5	2	3	1	2	2	3	1	3	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign and seal of HoD
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DEPARTMENT OF CHEMISTRY
EVALUATION SCHEME OF UG & PG PROGRAM AS PER NEP-2024-25
w.e.f. July, 2024-25
Certificate in Bioorganic and Chemical Analysis
1st Year / 2nd Semester



S. No.	Course Code	Course Title	(T)Theory (P) Practical	Course Type	Periods per Week			Evaluation Scheme			End Semester	Subject Total	Total Credit	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture	Tutorial	Practical	Class Test	Teacher Assessment	Total				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Values	Professional Ethics	
1.	B020201T/CH155	Bioorganic Chemistry	T	Core Major	3	1	-	15	10	25	75	100	04	√		√					
2.	B020202T/CH156	Material Science and Technology	T		3	1	-	15	10	25	75	100	04	√							
3.	B020203P/CH157	Biochemical Testing	P		-	-	4	15	10	25	75	100	02	√	√	√		√			
4.	B020204P/CH158	Material Analysis	P		-	-	4	15	10	25	75	100	02	√	√	√					
5.	- B030202T/MT148 - A040209T/LN109 -	- Basic Mathematics & Statics - Basics of Communication - EVS/BS	T + P	Minor (Elective)	3	1	4	15	10	25	75	100	06	√	√	√		√		√	-
6.	B000201V/CH144	Laboratory Safety & Sample Handling	T + P	Vocational	1	-	2	-	-	-	100	100	03	√		√		√	√	√	
7.	Z020201T/NS110	First Aid and Health	T	Co-curricular	2	-	-	15	10	25	75	100	02	√		√		√	√	√	
8.	B020205T/CH159	Advanced Application of Artificial Intelligence in Chemical Sciences*	T	Audit Course	2	-	-	-	-	-	100	100	00	√	√	√					-
TOTAL					14	03	14	90	60	150	650	800	23								

*Qualifying (Non-Credit Course)



Effective from Session: 2024-2025

Effective from Session: 2024-2025							
Course Code	B020101T /CH155	Title of the Course	Bioorganic Chemistry	L	T	P	C
Year	First	Semester	Second	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	This course aims to provide the students with a basic understanding of carbohydrates, amino acids, proteins, nucleic acids, and medicinal chemistry along with the synthesis, uses and mode of action of antibiotics and sulpha drugs, antipyretics analgesics, anesthetic drugs, cardiovascular drugs						

Course Outcomes

CO1	The students would be able to understand functioning of biomolecules essential for living organisms and the chemistry of carbohydrates.
CO2	The students would be able to understand the physiological function that regulates the proper growth and development of a human body along with the chemistry of proteins and nucleic acids.
CO3	The students would get an in-depth knowledge of medicinal chemistry and different classes of drugs like antibiotics, antipyretics, analgesics, antimalarial, and cardiovascular drugs.
CO4	The students would be able to understand the classification, synthesis, and mode of action of inhalation of intravenous anaesthetics and basal anaesthetics.
CO5	The students would be able to analyse different classes, structure, synthesis and mode of action of cardiac glycosides digoxin, and digitoxin; anti-hypertensive, hypotensive, and antiarrhythmic agents.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Chemistry of Carbohydrates	Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer's proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping-up (Kiliani Fischer method) and stepping-down (Ruff's & Wohl's methods) of aldoses. end-group interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose.)	8	1
2	Chemistry of Proteins	Classification of amino acids, zwitter ion structure and isoelectric point. Overview of primary, secondary, tertiary, and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein denaturation/ renaturation. Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions).	8	2
3	Chemistry of Nucleic Acids	Constituents of Nucleic acids: Adenine, guanine, thymine, and Cytosine (Structure only), Nucleosides and nucleotides (nomenclature), Synthesis of nucleic acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation	8	2
4	Medicinal Chemistry	Evaluation and study of introduction, examples and uses of various antibiotics, antipyretics and analgesics, antimalarial and cardiovascular drugs.	8	3
5	Anesthetic drugs	Introduction, Classification, synthesis, and mode of action of; Inhalation anaesthetics: Vinyl ether, Cyclopropane and Fluroxene; Intravenous anaesthetics: Thiopental Sodium Procaine hydrochloride, Tetracaine hydrochloride.	8	4
6	Cardiovascular drugs	Introduction, classification, structure, and mode of action of cardiac glycosides Digoxin, and Digitoxin; Anti-hypertensive and hypotensive drugs: structure, synthesis and Modeofaction of Losartan, lonidine, Antiarrhythmic agents: structure, synthesis and mode of action of Diisopyramide, Procainamide, Propranolol, Beritylium Tosilate	6	4
7	Antibiotics	Introduction and classification of antibiotics; beta lactam antibiotics: penicillins, its structure and mode of action, synthesis of Penicillin-v. Cephalosporin, Aminoglycoside: Streptomycin, Neomycin and Kenamycin.	6	4
8	Sulpha Drugs	Synthesis and uses of sulphathiazole, sulphaguanidine, sulphadiazine, sulphamethazine and sulphaacetamide.	8	5

Reference Books:

Davis, B. G., Fairbanks, A. J., Carbohydrate Chemistry, Oxford Chemistry Primer, Oxford University Press.

Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).

Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.

e-Learning Source:

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

<https://nptel.ac.in/courses/104/105/104105124/>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
C01	3	3	-	-	-	-	-	3	-	-	1	3
C02	3	2	-	-	-	-	-	2	-	-	2	2
C03	3	3	-	-	-	-	-	3	-	-	2	2
C04	2	1	-	-	-	-	-	1	-	-	1	3
C05	3	3	-	-	-	-	-	3	-	-	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B020202T/CH156	Title of the Course	Material Science and Technology	L	T	P	C
Year	First	Semester	Second	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The main aim of this course is to convey fundamental knowledge on materials and their applications in environmental protection, recycling and reuse of raw materials and treatment agents, economic benefits, and potential problems to our society. Upon completion of this theory course the students would gain knowledge of various materials, surface chemistry and interfacial phenomena, catalysis, metals and alloys, cement, ceramics and corrosion, polymer, glass, advanced materials and material balance, material balance without chemical reactions, material balance involving chemical reactions.						

Course Outcomes

CO1	The students would know about nanomaterials and their distinguished properties. They would also understand the concept of adsorption and micelles and their applications.
CO2	The students would be able to understand the basic working principle of water, steam and air boilers and also understand nucleations, crystallization, and equipment tank crystallizer.
CO3	The students would perceive a sound knowledge of crystals and also able to understand the nature of amorphous solids and their role in drug delivery. They would understand the importance of different separation techniques and their applications.
CO4	The students would understand filtration and types of extraction such as liquid-liquid extraction, acid-base extraction
CO5	The students would be able to know about the purification of organic compounds and their different types and their importance.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Basics of Materials synthesis	Advanced materials and Material balance: Nanomaterials, superconductors, biomaterials and fullerenes Material balance without chemical reactions: Flow diagram for material balance and material balance calculations for distillation, absorption, evaporation, extraction filtration, crystallization. Material balance involving chemical reactions: Concepts of stoichiometric equations, limiting reactant, excess reactant, percent excess, conversion, yield, selectivity and liquid phase reaction, gas phase reaction with or without recycle or bypass.	9	1
2	Surface chemistry and ceramics	Adsorption isotherm, sols, gels, emulsions, micro emulsions, micelles, aerosols, effect of surfactants. Introduction of ceramics, types, manufacturing processes and applications of ceramics.	8	1
3	Utilities in chemical industry	(i) A brief idea about water, steam and air boilers used in chemical industries (ii) A brief idea about fans, blowers, compressors and vacuum pumps, reciprocating pumps, gear pumps, centrifugal pumps, ejectors used in chemical industries.	8	2
4	Crystallization	Equilibrium solubility, super saturation, definition, nucleations, crystallization, equipment tank crystallizer and circulating liquid evaporator crystallizer.	8	2
5	X-ray powder diffraction and pharmaceuticals	Introduction, different solid forms and their role in drug development, salts, solvates, co-crystals, characterization of amorphous materials.	9	3
6	Distillation, evaporation and absorption	(i) Batch and continuous distillation, azeotropic and extractive distillation. (ii) Evaporator equipments; short tube evaporator and forced circulation evaporators. (iii) Equipments: Tray (Plate) towers for absorption, packed towers for absorption.	6	3
7	Filtration, extraction and drying	(i) Filter media and filter aids, filtration equipment- bed filters, plate and frame press filters, rotary drum filter and centrifuges. (ii) Extraction equipments: spray column and packed column extraction, rotating disc column extractors, liquid-liquid extraction, acid-base extraction. (iii) Purpose of drying, equipment- tray dryer, rotary dryer, flask dryer, fluid bed dryer, drum dryer, spray dryer.	6	4
8	Purification of organic compounds	Simple crystallization, fractional crystallization, sublimation, simple distillation, fractional distillation, distillation under reduced pressure, steam distillation, azeotropic distillation.	6	5

Reference Books:

- W. D. Bowen, H. K. Kingery, D.R. Uhlmann, Introduction to Ceramics, Wiley Publishers, New Delhi (1976)
 J. A. Kent, J. A. (ed), Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.(1997)
 G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao, Imperial college Press, London (2004)
 W. D. Callister Jr., D. G. Rethwisch Materials Science and Engineering: An Introduction , John Wiley & Sons (2018) .
 W. L. Mc. Cabe, J. C. Smith & Parriert Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore, 7th edition (2017)
 W.L.F. Armarego W.L.F. Armarego C. Chai, Purification of Laboratory Chemicals, Elsevier (2009)

e-Learning Source:

- <https://nptel.ac.in/courses/112106227>
<https://nptel.ac.in/courses/112/106/112106227/>
https://onlinecourses.nptel.ac.in/noc21_cy45/preview
<https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod4.pdf>
https://onlinecourses.nptel.ac.in/noc19_ch31/preview
<https://nptel.ac.in/courses/113/105/113105015/>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	-	-	-	1	-	3	-	-	3	2
CO2	1	2	-	-	-	2	-	1	-	-	2	2
CO3	1	3	-	-	-	1	-	2	-	-	1	3
CO4	3	2	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	1	-	2	-	-	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Executive Action Session 2024-2025							
Course Code	B020203P/CH57	Title of the Course	Biochemical Testing	L	T	P	C
Year	First	Semester	Second	0	0	4	2
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The objective of this course is to acquaint the biomolecules, simple drug development and compounds made of carbohydrates, proteins, amino acids, and nucleic acids through qualitative and quantitative experiments.						
Course Outcomes							
CO1	The students would learn to perform qualitative and quantitative analyses of proteins, amino acids, and fats						
CO2	The students would be inculcated with the skills to perform qualitative and quantitative analyses of biomolecules such as carbohydrates, and nucleic acids.						
CO3	The students would be able to perform qualitative and quantitative analysis of carbohydrates						
CO4	The students would learn the synthesis of simple drug molecules.						
CO5	The students would be able to determine and identify nucleic acids and their strength components.						

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Qualitative and Quantitative Analysis of Proteins, Amino Acids and Fats	Isolation of protein. Determination of protein by the Biuret reaction. TLC separation of a mixture containing 2/3 amino acids Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch To determine the concentration of glycine solution by formylation method. To determine the saponification value of an oil/fat. To determine the iodine value of an oil/fat	15	1,3
2	Qualitative and Quantitative Analysis of Carbohydrates	Separation of a mixture of two sugars by ascending paper chromatography Application of TLC and PC for the identification of natural coloring materials such as Lycopene from Tomato and Chlorophyll from Spinach Differentiate between a reducing/ non reducing sugar Synthesis of Osazones.	15	1,2
3	Synthesis of Simple Drug Molecules	To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. Synthesis of barbituric acid Synthesis of propranolol	15	1,4
4	Determination and Identification of Nucleic Acids	Determination of nucleic acids Extraction of DNA from onion/cauliflower	15	1,5

Reference Books:

Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education.
G. Svehla, Vogel's Qualitative Inorganic Analysis, 7e Pearson (2008).
Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009). 9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann.

e-Learning Source:

<https://www.labster.com/chemistry-virtual-labs/>
<https://www.vlab.co.in/broad-area-chemical-sciences>
<http://chemcollective.org/vlabs>
https://gtu.ge/Agro-Lib/Vogels_Textbook_Of_Quantitative_Chemical_Analysis_5th_ed_-_G_H_Jeffery.MsuCity.pdf

PO-PSO CO	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	-	-	-	-	-	-	3	1	-	-
CO2	1	2	-	-	-	-	-	-	1	1	-	-
CO3	3	1	-	-	-	-	-	-	1	2	-	-
CO4	2	1	-	-	-	-	-	-	3	1	-	-
CO5	3	3	-	-	-	-	-	-	2	2	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B020204P/CH158	Title of the Course	Material Analysis	L	0	T	0	P	4	C	2
Year	First	Semester	Second								
Pre-Requisite	10+2	Co-requisite	-								
Course Objectives	The chemistry lab program for this course is designed to give students the essential knowledge of preparing solutions of various concentrations, determination of concentrations, extraction of compounds from solutions, determination of refractive index of materials, molar refractivity and specific reactivity of solutions and chromatographic separations. These techniques and methods are very useful tools in various chemical industries such as pharmaceuticals, petroleum, food and materials.										

Course Outcomes	
CO1	The students would gain knowledge and skills to understand the laboratory methods and tests related to the estimation of molecular weight by depression in freezing point and elevation in boiling points.
CO2	The students would be able to understand and perform the extraction experiment. They would also learn to understand the phase diagram and separation of immiscible liquids.
CO3	The students would be able to perform and measure the refractive Index of liquids and its variation with change of medium.
CO4	The students would be able to understand the concept of chromatography and applications in industries.
CO5	The students would be able to perform the separation of organic compounds using thin layer paper chromatography.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Analysis of solution	Molecular weight determination by depression in freezing point and elevation in boiling points.	10	1,2
2	Extraction process	Phase diagram, partition coefficient. To find out the partition coefficient of – Iodine between CCl ₄ and water Acetic acid between water and benzene	10	2,3
3	Refractometer	Determination of Refractive Index of a liquid by Abbe's refractometer. Determination of Molar refractivity and specific refractivity of a liquid by using Abbe's refractometer.	20	2,4
4	Chromatography	Column, paper, thin layer To separate and identify the amino acids by ascending paper chromatography. To separate and identify the organic compound by the use of thin layer chromatography. Separation of a mixture of organic compound by column chromatography	20	2,5

Reference Books:

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

e-Learning Source:

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

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	-	-	-	-	-	-	2	1	-	-
CO2	2	3	-	-	-	-	-	-	1	2	-	-
CO3	1	2	-	-	-	-	-	-	2	1	-	-
CO4	1	1	-	-	-	-	-	-	1	2	-	-
CO5	3	1	-	-	-	-	-	-	3	3	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B000201V/CH144	Title of the Course	Laboratory Safety & Sample Handling	L	T	P	C
Year	First	Semester	Second	1	0	2	3
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	Main objective of the course is to impart the fundamental understanding of laboratory safety, managerial abilities for waste reduction, a basic understanding of chemistry, laboratory equipment, reagents, and solutions, as well as expertise in using high-tech equipment for any pharma/chemical company/testing lab, etc.						
Course Outcomes							
CO1	The students would learn the safety procedures and protocols to follow in a science laboratory.						
CO2	The students would learn waste management skills.						
CO3	The students would gain the elementary knowledge of chemistry.						
CO4	The students would learn to work in a chemistry lab and get familiarize with laboratory instruments, reagents, and solutions.						
CO5	The students would learn handling of sophisticated instruments for pharmaceutical/chemical company/testing labs, etc.						

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Safety In Science Laboratory	Theory: General Safety; Safe Handling of Chemicals and Glass wares; Working in Chemo-Safety/ Bio-Safety areas. Practical: Quantitative analysis; Determination of physical parameters of wastewater and solid waste. Temperature, Colour, Odour, pH, etc.	10	1
2	Managerial Skill in Minimizing Wastes	Theory: Four "Rs"- Reuse, Rework, Reduce, Recycle. Practical: Handling of different kinds of wastes and reuse. BOD, COD, & DO measurement.	10	1,2
3	Elementary Knowledge of Chemistry	Theory: Elementary knowledge of inorganic chemistry; Elementary knowledge of organic chemistry; Elementary knowledge physical chemistry. Practical: Study of Physico- chemical characteristics of e waste.	10	3
4	Laboratory Instruments	Theory: Principle and working of basic laboratory instruments Autoclave, Hot air oven, Incubator, pH meter, water bath, centrifuge, Refrigerator, colorimeter, Balance, Flame photometer, Microscope, Electrophoresis etc. Practical: Wastewater analysis and its treatment including primary, secondary, and tertiary treatment.	10	1,4
5	Reagents and Solutions	Theory: Molar solutions, normal solutions; Buffer solutions, solutions, saturated solutions, standard solutions. Dilution of the concentrated solution to desired concentration. Practical: Soil Sampling and its digestion; Physico-chemical characteristics of soil.	10	1,4
6	Expertise in Handling Sophisticated Instruments for Any Pharma/Chemical Companies/ Testing Labs etc.	Theory: Sustainability and the Chemical Industry; Chromatography and separation Techniques. Practical: TLC and Paper chromatographic techniques	10	1,5

Reference Books:

Industrial Chemistry by B.K Sharma, By Krishna Publications, GOEL Publishing House
 Environmental Chemistry by H. Kaur, Pragati Prakashan, Meerut.
 Environmental Chemistry by A. K.De , New Age International Publishers, (9th edition)
 Water Pollution by V.P. Kudesia, 4th edition, (latest) Pragati Prakashan, Meerut.
 Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education, sixth edition
 Hand book of solid waste management, second edition, McGraw-Hill education.

e-Learning Source:

https://www.researchgate.net/publication/320360474_Metal_Recovery_from_Industrial_and_Mining_Wastewaters
<https://www.routledge.com/Metal-Recovery-from-Industrial-Waste/Brooks/p/book/9781315895352>
https://rajyasabha.nic.in/rsnew/publication_electronic/E-Waste_in_india.pdf
<https://www.epa.gov/sites/production/files/2016-03/documents/industrial-waste-guide.pdf>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	-	-	-	-	3	2	1	1
CO2	3	3	-	-	-	-	-	-	2	3	2	2
CO3	2	3	-	-	-	-	-	-	3	2	2	1
CO4	3	1	-	-	-	-	-	-	3	2	1	1
CO5	3	3	-	-	-	-	-	-	3	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025							
Course Code	B020205T/CH159	Title of the Course	Advanced Application of Artificial Intelligence in Chemical Sciences	L	T	P	C
Year	First	Semester	Second	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The objective of this course is to acquaint the students with the origin of artificial intelligence, its evolution, scope, and significance. The idea is to know about the probable applications of AI in chemical sciences and how they can be implemented in reaction designing, synthesis, molecular prediction, reaction outcome prediction, template selection, molecular designing, and property prediction.						

Course Outcomes	
CO1	The learner would gain basic knowledge of the history and evolution of AI, as well as its scope and significance.
CO2	The learner would be taught problem solving through AI.
CO3	The learner would be able to evaluate different types of neural networks and deep learning, supervised and unsupervised learning, feature selection and engineering, and learning from observation.
CO4	The learner would be able to understand the machine learning applications and data analysis in chemistry, databases, and deep learning in chemistry.
CO5	The learner would be able to understand the implementation of AI in chemical synthesis, molecular prediction, prediction of reaction outcomes and designing of new reactions, reactant and template selection, molecular designing, and property prediction.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to artificial intelligence and problem solving through AI	<i>Introduction:</i> History and evolution of AI, comparison of human and computer skill, Component of AI, Scope and significance in different domains, Ethical considerations in AI development and deployment, Intelligent Agent, logical agent. <i>Problem solving through AI:</i> Defining problem as a state space search, analyzing the problem, solving problem by searching, informed search and Uninformed Search.	7	1, 2
2	Machine Learning Basics and Natural Language Processing	<i>Machine Learning:</i> Neural networks and deep learning, Supervised and unsupervised learning, feature selection and engineering, learning from observation, knowledge in learning. <i>Natural Language Processing:</i> Brief history of NLP, Text processing, Sentiment analysis, language translation, Early NLP system, ELIZA system, LUNAR system, General NLP system.	8	1
3	AI in Chemistry	Concept of Artificial intelligence, machine learning, Machine learning applications to data analysis in chemistry, databases, deep learning in chemistry, cheminformatics, molecular dynamics and simulation, chemical representation of atoms and molecules with molecular graph representation and Simplified Molecular Input Line Entry System (SMILES)	7	2
4	Applications of AI in Synthetic and Medicinal Chemistry and ethical issues:	Artificial intelligence in synthesis, molecular prediction, prediction of reaction outcomes and designing of new reactions, reactant and template selection, molecular designing and property prediction, computer-assisted synthesis design and prediction of biochemical pathways and new drug targets. Regulatory science, ethical consideration related to use of AI in chemical sciences	8	3

Reference Books:

Artificial Intelligence with Python: A Comprehensive Guide to Building Intelligent Apps for Python Beginners and Developers by Prateek Joshi
 Hands-On Artificial Intelligence for Beginners: An introduction to AI concepts, algorithms, and their implementation By Patrick D. Smith
 Machine Learning in Chemistry: The Impact of Artificial Intelligence Edited by Hugh M Cartwright
 Artificial Intelligence in Chemistry: Structure Elucidation and Simulation of Organic Reactions, Volume 73 Z. Hippe

e-Learning Source:

https://www.youtube.com/watch?v=Q_gWtkh5pEY
<https://www.youtube.com/watch?v=HbfFS7bA5M0>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	-	-	-	-	-	2	-	-	1	2
CO2	1	1	-	-	-	-	-	1	-	-	2	3
CO3	2	2	-	-	-	-	-	1	-	-	2	2
CO4	1	1	-	-	-	-	-	2	-	-	1	2
CO5	2	2	-	-	-	-	-	1	-	-	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025

Course Code	B030202T/MT148	Title of the Course	Basic Mathematics & Statistic	L	T	P	C
Year	First	Semester	Second	3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of elementary mathematics. By using the principal of applied mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the student will able to explore subject into their respective dimensions						

Course Outcomes	
CO1	Students will be able to interpret limits and continuity of functions. Also, they can find differential coefficient, differentiation of functions including function of a function, differentiation of parametric form, simple and successive differentiation.
CO2	Students will evaluate and interpret integration as an inverse of differentiation; They will be able to find indefinite integrals of standard form, integration by parts, by substitution and by partial fraction method. They can evaluate definite integrals.
CO3	Students can describe the basic concepts of simple random sampling and stratified random sampling. They can understand and find measures of central tendency (mean, median and mode), measures of variation (mean deviation and standard deviation), measure of coefficient of variation. Student will be able to understand and evaluate covariance and correlations, Karl Pearson's Coefficient of correlation and Spearman's coefficient of rank correlation. They can also be able to find regression by method of least squares.
CO4	Students can interpret the fundamental principle of counting. They will also be able to find permutations, permutations under certain conditions, combinations, combinatorial identities. They can also apply Binomial theorem (without proof)
CO5	Students will be able to understand the random experiment and associated sample space, events. They can also find probability and can use addition and multiplication theorems for finding probability (without proof). They will be able to understand probability distributions, and will be able to find Binomial, Poisson, and Normal distributions.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Limit and Continuity	Set and functions, left hand limit and right-hand limit, limits of function, continuity of function.	7	1
2	Differentiability	Definition of differential coefficient, differentiation of function including function of a function, differentiation of parametric form, simple and successive differentiation, Leibnitz rule.	8	1
3	Integrations	Integration as inverse of differentiation, indefinite integrals of standard form, integration by parts, substitution method and partial fraction method, evaluation of definite integrals.	8	2
4	Univariate Statistics	Basic concepts of simple random sampling and stratified random sampling, measures of central tendency (mean, median and mode), measures of variation (mean deviation, quartile deviation and standard deviation), coefficient of variation.	7	3
5	Bivariate Statistics	Covariance, correlations, scatter diagram, Karl Pearson's coefficient of correlation, Spearman's coefficient of rank correlation, regression and its coefficient, estimation of regression lines by the method of least square.	7	3
6	Permutations and Combinations	Fundamental principle of counting, permutations, permutations under certain conditions, combinations, combinatorial identities, Binomial theorem (without proof), some applications of Binomial theorem.	7	4
7	Probability theory	Random experiment and associated sample space, events, definition of probability, algebra of events, addition and multiplication theorems on probability (without proof), conditional probability, Baye's theorem.	8	5
8	Probability Distributions	Probability distribution, probability mass function, probability distribution function, expectations, Binomial, Poisson, normal distributions and their mean and variance, fitting the expected frequency of Binomial and Poisson distributions.	8	5

Reference Books:

- Murray R. Spiegel, 1980, Probability and Statistics, Schaum's (Outline Series) McGraw-Hill Book Co.
- Q. S. Ahmad, V. Ismail and S. A. Khan: Biostatistics, Laxmi Publications Pvt. Ltd.
- E. Kreyszig, "Advanced Engineering Mathematics", 5th Edition, Wiley Eastern, 1985.

e-Learning Source:

- NPTEL, MOOC

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3				1		3	2		2	2	
CO2	3				1		3	2		2	1	
CO3	3				3		3	2		1	2	
CO4	3				1		3	2		2	3	
CO5	3				3		3	2		2	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025							
Course Code	A040209- LN109	Title of the Course	Basic of Communication	L	T	P	C
Year	First	Semester	Second	3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	To enhance basic communication skill among the students. Students will also learn about the fundamentals of linguistics and Grammars.						
Course Outcomes							
CO1	Basic understanding of Communication and professional communication						
CO2	Basic knowledge of structural and functional Grammar. Learning language through literature.						
CO3	Basic tools of communication and improvement in communicative competence.						
CO4	Understanding the basic grammar and basic structure of language.						
CO5	Students will gain a fundamental understanding of the nature, branches, and history of Linguistics.						

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Professional Communication	Professional Communication: Its Meaning and Importance, Essentials of Effective Communication, Barriers to Effective Communication.	8	1
2	Language through Literature	A. Essays: 1. The Effect of Scientific Temper on Man by Bertrand Russell, 2. The Aim of Science and Humanities by Moody E Prior. B. 1. The Meeting Pool by Ruskin Bond, 2. The Portrait of a Lady by Khushwant Singh	8	2
3	Basic Vocabulary	Euphemism, One-word Substitution, Synonyms, Antonyms, Homophones, Idioms and Phrases, Common Mistakes, Confusable Words and Expressions.	8	3
4	Basic Grammar	Articles, Prepositions, Tenses, Concord, (Subject-Verb agreement), Modal Auxiliaries, Verbs: its Kinds and uses, Degrees of Comparison, Punctuation	8	4
5	Language and Linguistics	Language: Definition, characteristics and importance of Language Linguistics: Definition, nature, scope, branches, levels and types of Linguistics, Linguistics versus Traditional Grammar.	8	5

Reference Books:

Effective Communication Skills

Improve Your Communication Skills

Communication Skills Training

e-Learning Source:
www.ignou.com
www.swayam.com
www.coursera.com

PO-PSO CO	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3	-	-	2	3	3	2	-
CO2	2	3	1	2	3	-	-	2	3	3	1	-
CO3	1	3	1	2	3	-	-	3	3	2	2	-
CO4	3	3	2	2	3	-	-	2	2	3	1	-
CO5	2	3	2	3	3	-	-	3	3	2	3	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B020301T/CH232	Title of the Course	Chemical Dynamics & Coordination Chemistry	L	T	P	C
Year	Second	Semester	Third	3	1	0	4
Pre-Requisite	-	Co-requisite	-				
Course Objectives	Upon successful completion of this course, students should be able to describe the characteristics of the three states of matter and the different physical properties of each state of matter. Kinetic theory of gases, laws of crystallography, liquid state, and liquid crystals, conductometric, potentiometric, optical methods, polarimetry, and spectrophotometer techniques to study chemical kinetics and chemical equilibrium. After the completion of the course, students will be able to understand. Metal-ligand bonding in transition metal complexes, thermodynamic and kinetic aspects of metal complexes.						

Course Outcomes	
CO1	Students can explore the rate of reaction, order of reaction, concentration dependence, mathematical characteristics, and determination of reaction order, temperature effects, Arrhenius equation, activation energy, collision theory, transition state theory, rate constant expression, and thermodynamic aspects.
CO2	Students understand equilibrium constant, free energy, thermodynamic derivation of the law of mass action, Le-Chatelier's principle, reaction isotherm, reaction isochore-Claapeyron Clausius equation, phase terms (phase, component, degree of freedom), Gibbs phase rule derivation, phase equilibria of one component systems (water, CO ₂ , O ₂), and phase equilibria of two component systems (solid-liquid equilibria, simple eutectic systems).
CO3	Students understand kinetic theory of gases, van der Waals equation, critical phenomena, PV isotherms, continuity of states, law of corresponding states, reduced equation of state, and Maxwell's distribution of molecular velocities. Furthermore, Students able to explore liquid state, intermolecular forces, structure of liquids, differences between solids, liquids, and gases; study liquid crystals, their classification, structure, and phases; investigate liquids in solids (gels), their classification, preparation, properties, and applications.
CO4	Students are knowing the fundamentals of Werner's theory of coordination complexes, ligand classification, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature (up to two metal centers), isomerism in coordination compounds (constitutional, stereo, geometrical, and optical), focusing on square planar and octahedral complexes.
CO5	Explore electronic spectra, d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagrams, and the electronic spectrum of the [Ti(H ₂ O) ₆] ³⁺ complex ion. Study magnetic properties, types of behavior, methods for determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_S and μ effective values, orbital contribution to magnetic moments, and applications of magnetic moment data for 3d-metal complexes.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Chemical Kinetics & Theories of chemical kinetics	i. Rate of a reaction, molecularity and order of reaction, 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, half-life method, and isolation method. ii. Effect of temperature on rate of reaction; Arrhenius equation; concept of activation energy; Simple collision theory based on the hard sphere model, transition state theory (equilibrium hypothesis); Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).	8	1
2	Chemical Equilibrium	Equilibrium constant and free energy; thermodynamic derivation of the law of mass action; Le-Chatelier's principle, reaction isotherm, and reaction isochore-Claapeyron Clausius equation and its applications.	7	2
3	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, CO ₂ , and O ₂ systems Phase equilibria of two component systems: Solid-liquid equilibria, simple eutectic (Bi-Cd, Pb Ag systems)	7	2
4	Kinetic theories of gases	i. <i>Gaseous State</i> : Postulates of the kinetic theory of gases: deviation from ideal behaviour, van der Waals equation of state. ii. <i>Critical phenomena</i> : PV isotherms of real gases, continuity of states, the isotherms of the Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. iii. <i>Molecular Velocities</i> : Qualitative discussions of Maxwell's distribution of molecular velocities, collision number, mean free path, and collision diameter.	7	3
5	Liquid State	i. <i>Liquid State</i> : Intermolecular forces and the structure of liquids (a qualitative description) Structural differences between solids, liquids, and gases. ii. <i>Liquid crystals</i> : Difference between liquid crystal, solid, and liquid; classification and structure of the nematic and cholesterol phases. iii. Liquids in solids (gels): Classification, preparation, and properties, inhibition, general application.	7	3
6	Coordination Chemistry	Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, and geometrical and optical isomerism in square planar and octahedral complexes.	8	4
7	Theories of Coordination Chemistry	i. Metal-ligand bonding in transition metal complexes, limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral, and square planar complexes, the Jahn Teller effect, and factors affecting the crystal-field parameters. ii. <i>Thermodynamic and kinetic aspects of metal complexes</i> : a brief outline of the thermodynamic stability of metal complexes; the concept of hard and soft acids and bases and factors affecting their stability; the stability constants of complexes and their determination; substitution reactions of square planar complexes	8	4

8	Inorganic Spectroscopy and Magnetism	i. Electronic spectra of transition metal complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagrams for d1 and d9 states, and discussion of the electronic spectrum of the $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion. ii. Magnetic properties of transition metal complexes, types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ effective values, orbital contribution to magnetic moments, application of magnetic moment data for 3d- metal complexes.	8	5
Reference Books:				
Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).				
Ball, D. W. Physical Chemistry Thomson Press, India (2007).				
Cotton, F.A, Wilkinson, G and Gaus, P. L., Basic Inorganic Chemistry, 3rd Edition, Wiley 1995				
Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977				
Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994				
Shriver, D.E Atkins, P.W and Langford, C. H, Inorganic Chemistry, Oxford University Press, 1994.				
Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.				
Sharpe, A. G, Inorganic Chemistry, ELBS, 3RD edition, 1993; Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).				
Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001; Bahl and Bahl, Essential of Physical Chemistry, S.Chand				
R Gopalan & V Ramalingam, Concise Coordination Chemistry, Vishal publishing house; Tn Srivastva and Pc Kampoj, Systematic Analytical Chemistry, Shoban Lal Nagin Chand				
e-Learning Source:				
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://swayam.gov.in/				
https://www.coursera.org/browse/physical-science-and-engineering/chemistry				

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	1	1	-	-	-	-	-	-	-	-	1	-	-	1	1
CO2	3	2	1	2	-	-	-	-	-	-	-	-	1	-	-	2	1
CO3	2	3	1	1	-	-	-	-	-	-	-	-	1	-	-	2	1
CO4	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-	1	1
CO5	2	2	1	1	-	-	-	-	-	-	-	-	1	-	-	1	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B020302P/CH234	Title of the Course	Physical Analysis	L	T	P	C
Year	Second	Semester	Third	-	-	4	2
Pre-Requisite	-	Co-requisite	-				
Course Objectives	Students who successfully complete this course should be able to calibrate instruments and prepare solutions of various concentrations, estimate components through volumetric analysis, as well as perform dilatometric experiments: one- and two-component phase equilibrium experiments.						

Course Outcomes	
CO1	Students able to demonstrate proficiency in the following concepts: calibration of laboratory equipment; dilution of solutions, including the conversion of 0.1 M to 0.001 M solutions; Understanding of the molecular concept and concentration units, including molecular weight, formula weight, and equivalent weight, and knowledge of various concentration units.
CO2	Students can determine experimentally the surface tension and viscosity of a pure liquid or solution.
CO3	Students identify boiling points of five organic compounds with boiling points under 180 °C.
CO4	Student becomes able to determine the transition temperature of the substance using thermometric or dilatometric methods.
CO5	Students learn the solutes' effect on critical solution temperature and construct phase diagrams.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Strengths of Solution	i. Calibration of fractional weights, pipettes, and burettes. Preparation of standard solutions. ii. Dilution: 0.1 M to 0.001 M solutions. iii. Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight. iv. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles	20	1
2	Surface Tension and Viscosity	i. Determination of the surface tension of a pure liquid or solution ii. Determination of the viscosity of a pure liquid or solution	10	2
3	Boiling point and Transition Temperature	i. Boiling point of common organic liquid compounds (any five): n-butyl alcohol, cyclo-hexanol, ethyl methyl ketone, cyclo-hexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde, and acetophenone [The boiling points of the chosen organic compounds should preferably be within 180 °C.] ii. Transition Temperature: Determination of the transition temperature of the given substance by thermometric or dilatometric method (e.g. MnCl ₂ ·4H ₂ O or SrBr ₂ ·2H ₂ O)	20	3, 4
4	Phase Equilibrium	i. To study the effect of a solute (e.g., NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g., phenol-water system) and to determine the concentration of that solute in the given phenol-water system. ii. To construct the phase diagram of a two-component (e.g., diphenylamine-benzo-phenone) system by the cooling curve method.	10	5

Reference Books:

G. D. Christian, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York (2004).

D.C. Harris, Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman (2016).

E. Stocchi, Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).

J. A. Kent, (ed) Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi, (1997).

Pani, B. Textbook of Environmental Chemistry, I.K. International Publishing House, (2017).

A. K. De, Environmental Chemistry, New Age International Pvt, Ltd, New Delhi (2012).

S. M. Khopkar, Environmental Pollution Analysis, New Age International Publishe (2010)

e-Learning Source:

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

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

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	-	2	3	-	-
CO4	2	3	1	2	-	-	-	-	-	-	-	-	-	1	1	-	-
CO5	2	2	2	1	-	-	-	-	-	-	-	-	-	1	1	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B020401T/CH239	Title of the Course	Quantum Mechanics and Analytical Techniques	L	T	P	C
Year	Second	Semester	Fourth	3	1		4
Pre-Requisite	-	Co-requisite	-				
Course Objectives	The students learn about the atomic structure, elementary quantum mechanics, wave function and its significance; the Schrodinger wave equation and its applications; Molecular orbital theory, basic ideas – Criteria for forming molecular orbitals from atomic orbitals; Molecular Spectroscopy, Rotational Spectrum, vibrational Electronic Spectrum: photochemistry and kinetics. Analytical chemistry plays an enormous role in our society, such as drug manufacturing, process control in industry, environmental monitoring, medical diagnostics, food production, and forensic surveys. It is also of significant importance in different research areas. Analytical chemistry is a science that creates and develops knowledge to improve chemical analysis to respond to increasing or new demands.						

Course Outcomes	
CO1	Students will be able to explore new areas of research in both chemistry and the allied fields of science and technology. This is especially in elementary quantum mechanics.
CO2	Students will be able to function as members of an interdisciplinary problem-solving team in molecular spectroscopy.
CO3	Students will be skilled at problem solving, critical thinking, and analytical reasoning as applied to scientific problems. This is done with the help of various spectroscopic techniques.
CO4	Students will learn how to determine the structure of organic molecules using IR, NMR, and mass spectroscopic techniques.
CO5	To develop the basic skills required for purification, solvent extraction, TLC, and column chromatography.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	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 hypothesis. Heisenberg uncertainty principle, Hamiltonian Operator. Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one-dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO- H ₂ ⁺ ion, calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ , σ^* , π , π^* orbitals and their characteristics.	10	1
2	Molecular Spectroscopy	Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom	5	2
3	Rotational Spectrum, Vibrational Spectrum and Raman spectrum	i. 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. ii. 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 anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. iii. 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.	10	3
4	UV-Visible Spectroscopy	Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λ max, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λ max for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers (Cis and trans stilbene).	5	3
5	Infrared Spectroscopy (IR Spectroscopy)	Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitrile), Effect of H- bonding, conjugation, resonance and ring size of cyclic ketones and lactones on IR absorptions; Fingerprint region and its significance; application in functional group analysis and interpretation of I.R. Spectra of simple organic compounds. Identification of the Carbonyl group in Ketones, Aldehydes, Carboxylic acids, Esters, and Amides using IR Spectroscopy.	8	4
6	¹ H-NMR Spectroscopy (PMR)	NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple	8	4

		compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules such as Ethanol, Ethyl acetate, acetone, acetaldehyde, dimethylformamide, Cis and trans 1,2- dimethyl cyclopropanone, propene, vinyl chloride, acetophenone, benzaldehyde, phenol, Toluene and ethyl benzene.		
7	Introduction to Mass Spectrometry	Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement.	6	4
8	Separation Techniques: Solvent extraction	Classification, principle, and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media. Chromatography: Classification, principle, and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution, and displacement methods.	8	5

Reference Books:

- Alberty, R. A., Physical Chemistry, 4th edition Wiley Eastern Ltd, 2001; Atkins, P. W., the elements of physical chemistry, Oxford, 1991
- Barrow, G. M., International student Edition. McGraw Hill, McGraw-Hill, 1973; Cotton, F. A., Wilkinson, G and Gaus, P. L., Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J. D., Concise Inorganic Chemistry 4th Edition ELBS, 1977; Clayden, J., Greeves, N., Warren, S., Organic Chemistry, Second edition, Oxford University Press 2012.
- Silverstein, R. M., Bassler, G. C., Morrill, T. C. Spectrometric Identification of Organic Compounds, John Wiley and Sons, INC, Fifth edition.
- Willard, H. H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988; Christian, G. D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C.: Exploring Chemical Analysis, 9th Ed. New York, W. H. Freeman, 2016.; Khopkar, S. M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- Mukherji, Singh, Kapoor, Organic Chemistry, Vol 1 and 2. New Age International 2014; R. I. Madan, Chemistry For Degree Students Elective Sem V/VI As Per Cbs Quantum And Spectroscopy, S Chand Publishing
- Y. R. Sharma, Elementary Organic Spectroscopy Vol 4, S Chand; Gurdeep Raj, Advanced Physical Chemistry, Krishna Publishing
- Pavia, D. L. et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed.
- K. L. Kapoor, A Textbook Of Physical Chemistry - Quantum Chemistry And Molecular Spectroscopy, Volume 4, Macmillan; T. N. Srivastava And P. C. Karmaj, Systematic Analytical Chemistry, Shoban Lal Nagin Chand

e-Learning Source:

- <https://www.coursera.org/courses?query=chemistry&languages=en>
- <https://www.mooc-list.com/tags/physical-chemistry>
- <https://www.coursera.org/learn/physical-chemistry>
- <https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/>
- <http://hecontent.upsdc.gov.in/Home.aspx>
- <https://nptel.ac.in/courses/104/108/104108078/>
- <https://nptel.ac.in/courses/104/106/104106122/>
- <https://nptel.ac.in/courses/104/108/104108124/>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	1	-	-	-	-	-	-	-	-	1	-	-	1	1
CO2	3	2	1	2	-	-	-	-	-	-	-	-	2	-	-	1	1
CO3	2	3	2	3	-	-	-	-	-	-	-	-	3	-	-	3	3
CO4	3	3	2	3	-	-	-	-	-	-	-	-	2	-	-	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B020402P/CH241	Title of the Course	Instrumental Analysis	L	T	P	C
Year	Second	Semester	Fourth			4	2
Pre-Requisite	-	Co-requisite	-				
Course Objectives	Students will be able to perform, design, interpret, and document laboratory experiments using critical thinking and scientific inquiry. This is at a level suitable to succeed in an entry-level position in the chemical industry or a chemistry graduate program.						

Course Outcomes	
CO1	Students will be able to explore new areas of research in both chemistry and allied fields of science and technology, basically in molecular weight determination.
CO2	Students will be able to function as members of an interdisciplinary problem-solving team in spectrophotometer.
CO3	Students will be skilled in problem solving, critical thinking, and analytical reasoning as applied to scientific problems, especially spectroscopy.
CO4	Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques.
CO5	To develop the basic skills required for purification, solvent extraction, TLC, and column chromatography.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Molecular Weight Determination	i. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. ii. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy.	15	1
2	Spectrophotometry	i. To verify Beer – Lambert Law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determining the concentration of the given solution of the substance from absorption measurement ii. Determination of pKa values of indicator using spectrophotometry.	15	2
3	Spectroscopy	i. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). ii. Assignment of labelled peaks in the ^1H NMR spectra of the known organic compounds explaining the relative δ -values and splitting pattern. iii. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).	15	3, 4
4	Chromatographic Separations	i. Paper chromatographic separation of following metal ions: Ni (II) and Co (II); Cu(II) and Cd(II) ii. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography (TLC) iii. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values TLC separation of a mixture of dyes (fluorescein and methylene blue).	15	5

Reference Books:

Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009; Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004; Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016; Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

Mikes, O. & Chalmers, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.

Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

e-Learning Source:

<https://www.youtube.com/watch?v=xHQM4BbR040&pp=ygUcc3BIY3Ryb3Bob3RvbWV0ZXIgaXhwZXJpbWVudA%3D%3D>

<https://www.youtube.com/watch?v=LbsNI3WgUso&pp=ygUMc3BIY3Ryb3Njb3B5>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO2	1	2	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-
CO3	3	3	1	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO4	2	3	3	1	-	-	-	-	-	-	-	-	-	1	2	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-25

Course Code	B020501T/CH337	Title of the Course	Organic Synthesis-A	L	T	P	C
Year	Third	Semester	Fifth	3	1	0	4
Pre-Requisite	Diploma	Co-requisite	-				
Course Objectives	The main objective of this course is to provide key knowledge of hydrocarbons, which are the principal constituents of petroleum and natural gas. They serve as fuels and lubricants as well as raw materials for the production of plastics, fibres, rubbers, solvents, and industrial chemicals. This course will provide a broad foundation for the synthesis of hydrocarbons. Alcohols and carbonyl compounds are industrially important compounds. The industries of plastics, fibres, petroleum, and rubber will especially recognize this course.						

Course Outcomes	
CO1	Students would be able to remember and analyse the synthesis, chemical properties, and reactions of aliphatic hydrocarbons.
CO2	Students would be able to evaluate the physical and chemical properties of aromatic hydrocarbons and their chemical reactions.
CO3	Students would be able to understand and comprehend the chemistry of alcohols and phenols.
CO4	Students would perceive the sound knowledge of methods of their formation, physical properties, and chemical reactions of ethers and epoxides.
CO5	Students will be able to understand and rate the formation processes, chemical reactions, and mechanisms of nucleophilic substitution reactions of alkyl halides, as well as SN^2 and SN^1 reactions with energy profiles and the making of different pesticides.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Chemistry of Alkanes and Cycloalkanes	A) Alkanes: Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity B) Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds	8	1
2	Chemistry of Alkenes	Methods of formation of alkenes, Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, syn and anti-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic 1,2 addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of E- and Z-alkenes	12	1
3	Chemistry of Alkynes	Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes	6	1
4	Aromaticity and Chemistry of Arenes	Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.	10	2
5	Chemistry of Alcohol	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 pinacol pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol	8	3
6	Chemistry of 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 rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	6	3
7	Chemistry of Ethers and Epoxides	Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.	5	4
8	Chemistry of Organic Halides	Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN^2 and SN^1 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,	5	5

Reference Books:

Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren, Second edition, Oxford Publication.

Organic Chemistry by T.W.Graham Solomons, and Craig B. Fryhle, Ninth edition, Wiley Publication.

Organic Chemistry by IL Finar, Volume 1 & 2, Sixth edition, Pearson Publication
Advanced Organic Chemistry (Reactions, Mechanisms and Structure): Michel B. Smith and Jerry March, 4th Edition, Wiley Interscience Publication.
A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Six edition, Pearson publication.
Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd, and Saibal Kanti Bhattacharjee, Seventh edition,
Mukeherji, Singh, Kapoor, Organic Chemistry , Vol 1, New Age International 2014
Carey, F. A., Giuliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
Mukherji, Singh, Kapoor, Organic Chemistry, volume 1,2 and 3, 2014, New Age International.
Arun Bahl & B S Bahl, Advanced Organic Chemistry, S. Chand Publishing 13. TN SRIVAS
e-Learning Source:
http://heecontent.upsdc.gov.in/Home.aspx
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://nptel.ac.in/courses/104/106/104106096/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	-	-	-	2	-	1	-	-	1	3
CO2	2	2	-	-	-	2	-	2	-	-	2	2
CO3	1	3	-	-	-	1	-	3	-	-	3	3
CO4	1	3	-	-	-	2	-	2	-	-	2	1
CO5	2	3	-	-	-	1	-	2	-	-	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Effective from Session: 2024-2025							
Course Code	B020502T/CH338	Title of the Course	Rearrangements and Chemistry of Group Elements	L	T	P	C
Year	Third	Semester	Fifth	3	1	0	4
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The primary goal of this course is to impart a thorough understanding of significant rearrangement reactions in the field of organic chemistry. In addition, the student will receive a concise explanation of the concept of catalysis, along with pertinent examples. The text also discusses the chemistry of several elements and provides a comprehensive comprehension of the s, p, d, and f block elements and their significant attributes. Additionally, this text will provide detailed explanations of the applications of several significant inorganic chemicals.						

Course Outcomes	
CO1	The learner will be able to understand some important rearrangement reactions in organic chemistry, along with their mechanistic insights and factors affecting the rate of the reaction.
CO2	The learner will be able to remember and understand the concept of catalysis, the effects of homo and hetero catalysts, and how they impact the overall rate of the reactions. Along with that, the concept of enzymatic catalysis will also be introduced.
CO3	The learner will have a thorough understanding and evaluation of the modern periodic table and different periodic properties. The characteristics of group 1 and 2 elements will also be elaborated. The learner will also be taught the characteristics of P block elements, including groups 13–18. The anomalous properties of the first element of each group and the diagonal relationship will also be elucidated. A comprehension of the properties of inert gases will also be done. The chemistry of some important inorganic compounds will also be discussed.
CO4	The learner will have a comprehensive understanding and analyze the characteristics of d and f block elements, and an insight into important phenomena like lanthanide contraction and its consequences will also be elucidated. The chemistry of some important compounds of d and f block elements will also be discussed.
CO5	The learner will be able to understand and evaluate the concept of bioinorganic chemistry. The importance of essential and trace elements will also be discussed, along with their deficiency diseases. The biological role of alkali and alkaline elements will also be elaborated, and the physiological functioning of important biomolecules like haemoglobin and myoglobin will also be discussed.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Rearrangement reactions in Organic Chemistry	Mechanistic insights of the following rearrangements: Pinacol-pinacolone, Demjanov, Benzil Bensilic acid, Favorskii, Hoffman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement.	8	1
2	Catalysis in Organic Chemistry	General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation, or regeneration of catalysts. Phase transfer catalysts, Enzyme catalysis; Michaelis-Menten equation, turn-over number.	8	2
3	Periodic properties and Chemistry of s block elements	Modern periodic table and trends in properties like atomic and ionic radii, ionization energy, electron affinity, electronegativity, and chemical reactivity. Group - 1 and 2 Elements General introduction, electronic configuration, and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group and diagonal relationship.	8	2
4	Chemistry of p block elements	General Introduction: Electronic configuration and general trends in physical and chemical properties of elements anomalous properties of the first element of each group and diagonal relationship. Chemistry of inert gases.	8	3
5	Chemistry of some important compounds	Chemistry of some important compounds like boranes, interhalogens, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride	6	3
6	Chemistry of d block elements	General introduction, electronic configuration, and characteristics including ionization energy, oxidation states, atomic radii, colour, catalytic behaviour, and magnetic properties. Preparation, properties, and uses of $K_2Cr_2O_7$ and $KMnO_4$.	8	4
7	Chemistry of f block elements	Lanthanides and actinides: General introduction, electronic configuration, and characteristics including ionization energy, oxidation states, atomic radii, colour, and magnetic properties. Lanthanide contraction and its consequences. Preparation, properties and uses of ceric ammonium sulphate	8	4
8	Role of inorganic elements in biology	Essential and trace elements: their role in biological systems, deficiency diseases and toxicity. Synergistic and antagonistic effect. Metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions.	6	5

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962
- R.D.Madan, Principles of Inorganic Chemistry, S CHAND PUBLISHERS
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Mukeherji, Singh, Kapoor, Organic Chemistry, Vol 1, New Age International 2014

e-Learning Source:

- <http://heecontent.upsdc.gov.in/Home.aspx>
- <https://nptel.ac.in/courses/104/106/104106096/>

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
C01	3	2	1	-	1	-	-	2	-	-	2	3
C02	2	2	1	-	2	-	-	1	-	-	2	2
C03	2	3	1	-	1	-	-	3	-	-	3	2
C04	3	2	1	-	1	-	-	2	-	-	2	3
C05	2	3	1	-	1	-	2	1	-	-	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD



Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	B190503P/CH339	Title of the Course	Quantitative Analysis	L	T	P	C
Year	Third	Semester	Fifth	0	0	4	2
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The main objective of this course is to deliver essential knowledge of laboratory techniques for the analysis of inorganic salts, the identification of functional groups, and the separation of organic mixtures.						

Course Outcomes	
CO1	Students would be able to understand the laboratory methods and tests related to inorganic mixtures and organic compounds.
CO2	Students would be able to identify acids and basic radicals in an inorganic mixture.
CO3	Students would be able to perform and analyse the separation of organic compounds from mixtures.
CO4	Students would be able to understand the elemental analysis of organic compounds.
CO5	Students would be able to identify and analyse functional groups in organic compounds and identify organic compounds.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Inorganic Qualitative Analysis	Semi micro-Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3	16	1,2
2	Elemental analysis and identification of functional groups	Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.	14	2,3
3	Separation of Organic Mixture	Analysis of an organic mixture containing two solid components using water, NaHCO ₃ , NaOH for separation and purification of suitable derivatives	10	2,4
4	Identification of organic compounds	Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives. Identification of the organic compounds by IR and NMR Spectroscopy. (Photocopies of the spectra to be provided to the students)	20	2,5

Reference Books:

Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of practical organic chemistry prentice Hall, 5th edition, 1996

Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960

Harris, D.C. Exploring Chemical Analysis, 9thEd. New York, W.H. Freeman, 2016

Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009. Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University

e-Learning Source:

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

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

<http://chemcollective.org/vlabs>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	-	1	2	-	3	2	2	1	-	-
CO2	2	3	-	1	1	-	2	1	3	2	-	-
CO3	3	2	-	1	2	-	2	2	2	1	-	-
CO4	2	3	-	1	1	-	3	2	3	2	-	-
CO5	3	1	-	1	2	-	3	2	3	3	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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**Effective from Session:** 2024-25

Course Code	B020504R/CH340	Title of the Course	Chemistry Research Project-1	L	T	P	C
Year	Third	Semester	Fifth	0	0	10	5
Pre-Requisite	Diploma	Co-requisite	-				
Course Objectives	To provide the industrial exposure and enhance technical skills of students						

Course Outcomes

CO1	Hands on training
CO2	Integrate classroom theory with laboratory practice.
CO3	Understanding professional ethics of industry and code of conduct.
CO4	Essential training in laboratory safety procedures
CO5	Compilation of data and report writing

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	1	2	1	-	-	2	2	2	1
CO2	2	1	1	2	1	2	-	-	3	2	1	1
CO3	1	1	3	3	1	3	-	-	3	3	2	1
CO4	1	3	2	1	1	1	-	-	2	3	1	1
CO5	2	2	1	3	3	1	-	-	3	2	1	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**Name & Sign of Program Coordinator****Sign & Seal of HoD**

Effective from Session: 2024-2025

Course Code	B020601T/CH353	Title of the Course	Organic Synthesis B	L	T	P	C
Year	Three	Semester	Six	3	1	0	4
Pre-Requisite	Diploma	Co-requisite	-				
Course Objectives	This paper provides detailed knowledge of the synthesis of various classes of organic compounds and functional groups through interconversion. Organic synthesis is the most important branch of organic chemistry, which provides jobs in production and QC departments related to chemicals, drugs, medicines, FMCG, etc. industries. The study of natural products and heterocyclic compounds offers an excellent strategy towards identifying novel biological probes for several diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a few diseases, including cancer and infection.						

Course Outcomes	
CO1	Students would perceive the sound knowledge of various reagents for oxidation and reduction in organic synthesis. And understand organomagnesium, organozinc, and organolithium compounds, including their formation and diverse chemical reactions.
CO2	Students will develop a comprehensive knowledge of aldehydes, ketones, and carboxylic acids. Learn how to name them, make them, what their physical properties are, and how they react to different things. For example, learn how nucleophilic additions work and how to make functional derivative preparations. Achieve proficiency in organic synthesis.
CO3	Students will develop the knowledge necessary for a proficient understanding of organic synthesis via enolates and the organic chemistry of nitrogen-containing compounds.
CO4	Students would perceive the sound knowledge and comprehensive understanding of heterocyclic molecular structures, synthesis, reactions, and substitution mechanisms.
CO5	Students will develop a comprehensive understanding of alkaloids and terpenes: their structures, physiological roles, synthetic methods, and medicinal importance.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Reagents in Organic Synthesis	Oxidation with DDQ, CAN and SeO ₂ , mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetroxide. Reduction with NaBH ₄ , LiAlH ₄ , Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	8	1
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.	8	1
3	Chemistry of Aldehydes and ketones	Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner,	8	2
4	Carboxylic acids and their Functional Derivative	Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.	6	2
5	Organic Synthesis via Enolates	Acidity of α -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	8	3
6	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, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction.	8	3
7	Heterocyclic Chemistry	Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles,	8	4
8	Natural Products	Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Medicinal importance of Nicotine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	6	5

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.

e-Learning Source:
http://heecontent.upsdc.gov.in/Home.aspx https://nptel.ac.in/courses/104/103/104103111/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm https://nptel.ac.in/courses/104/103/104103071/#
https://swayam.gov.in/
http://heecontent.upsdc.gov.in/Home.aspx https://nptel.ac.in/courses/104/103/104103111/
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	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	-	-	2	-	-	3	-	2	3	3
CO2	3	3	-	-	2	-	-	3	-	2	2	3
CO3	3	3	-	-	2	-	-	3	-	2	3	3
CO4	3	3	-	-	2	-	-	3	-	2	2	3
CO5	3	3	-	-	2	-	3	3	-	2	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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SDG-3,4

Effective from Session: 2024-2025

Course Code	B020602T/CH354	Title of the Course	Chemical Energetics and Radio Chemistry	L	T	P	C
Year	Third	Semester	Six	3	1	0	4
Pre-Requisite	Diploma	Co-requisite	-				
Course Objectives	The main aim of this course is to convey fundamental knowledge of the laws of thermodynamics and their applications, phase equilibria of one- and two-component systems, electrochemistry, ionic equilibrium applications of conductivity, and potentiometric measurements. Higher education studies have proven that to be quite important. The learner will be able to investigate topics in their appropriate dimensions after completing the course.						

Course Outcomes

CO1	Students would perceive the sound knowledge of the first law of thermodynamics and various energies such as internal energy and enthalpy. Students would also gain insight into the knowledge of thermochemistry and various reaction enthalpies. Students gained insight into the laws of thermodynamics, the importance of entropy, and gibbs free energy. Nernst heat theorem, statement, and concept of residual entropy.
CO2	Students would evaluate the fundamentals of electrochemistry and enhance their knowledge of the basics of electrochemistry, conductometric titrations, and the Ostwald dilution law. Degree of ionization. Students also learn about electrodes, electrochemical cells, pH, buffer solutions, and salt hydrolysis.
CO3	Students would evaluate the fundamentals of the surface chemistry laws of adsorption and colloids. Students also learn about dilute solutions and colligative properties. It enables us to understand the reactants in catalysis.
CO4	Students would have a solid knowledge of the basics of photochemistry, the Jablonski diagram, and different photophysical processes.
CO5	Students would be able to learn about radioactivity. It enables us to understand the applications of radiochemistry in energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, and nuclear medicine.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	First Law of Thermodynamics	Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule Thomson coefficient and inversion temperature. Calculation of w , q , dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Thermochemistry: Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation	8	1
2	Thermodynamics-II	Second Law of Thermodynamics, Need for 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 & T , entropy as a function of P & T , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmholtz work function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P , V and T . Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications	8	1
3	Electrochemistry	Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances 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 equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method.	7	2
4	Ionic Equilibrium	Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells-Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pK_a , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hassel equation, application of buffer solution. Hydrolysis of salts.	8	2
5	Surface Chemistry	Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogeneous catalysis (single reactant); Colloids: Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation	7	3
6	Colligative Properties	Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, 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, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.	8	3
7	Photo Chemistry	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, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.	6	4
8	Radiochemistry	Natural and induced radioactivity; radioactive decay- α -decay, β -decay, γ -decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttall rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine- ^{99m}Tc radiopharmaceuticals.	8	5

Reference Books:

Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
e-Learning Source:
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	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
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CO3	3	3	-	-	-	-	2	3	-	-	2	3
CO4	3	3	-	-	-	-	3	3	-	-	2	3
CO5	3	3	-	-	-	-	3	3	-	-	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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SDG: 4, 8



Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	B020603P/CH355	Title of the Course	Analytical Methods	L	T	P	C
Year	Third	Semester	Six	0	0	4	2
Pre-Requisite	10+2	Co-requisite	-				
Course Objectives	The main objective of this course is to provide essential knowledge of laboratory techniques and tests for estimating metal ions and chromatographic separation of amino acids and sugars. The lab course also delivers knowledge and experimentation-based understanding of the ionization enthalpies of acids and bases.						

Course Outcomes	
CO1	Students would be able to learn about laboratory methods and tests related to the estimation of metal ions and gravimetric analysis.
CO2	Students would be able to understand and evaluate the chromatography separation and perform the paper chromatography experimentation.
CO3	Students would be able to remember, understand, and perform the thin layer chromatography experimentation.
CO4	Students would be able to understand the solubility behavior of compounds at different temperatures.
CO5	Students would be able to understand, analyze, and perform experiments related to the enthalpy of neutralizing acids and bases and lattice energy calculations.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Gravimetric Analysis	Estimation of one anion and cation in a given salt: 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni(dimethylglyoxime) 3. Analysis of Ba as BaSO ₄	15	1
2	Paper Chromatography	Ascending and Circular R _f of organic compounds, Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent ninhydrin. Separation of a mixture of D, L alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent ninhydrin. Separation of monosaccharides a mixture of D- galactose and D –fructose using n- butanol: acetone: water (4:5:1). Spray reagent aniline hydrogen phthalate	15	2,3
3	Thin Layer Chromatography	Determination of R _f values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- dinitro phenyl hydrazones of acetone, 2- butanone, hexan-2, and 3-one using toluene and light petroleum (40:60), Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)	15	2,3
4	Thermochemistry	To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolution process. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle.	15	4,5

Reference Books:

Practical Chemistry: For B.Sc, S. Chand Limited, OP pandey, DN Bajpai, 2022.
 Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
 B.Sc.-III Practical Chemistry, Dr. Pradip P. Deohate, ISBN : 978-93-5445-764-7
 Instrumental Methods of Analysis, CBS Publishers & Distributors, Willard M.H., ISBN 9788123909431

e-Learning Source:

<https://youtu.be/UHYfgwjE2i4>
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<https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXII/chemistry/lelm103.pdf>
<https://rltsc.edu.in/wp-content/uploads/2021/03/E-Book-B.Sc.-III-Practical-Chemistry.pdf>

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	-	-	-	-	1	-	2	1	-	-
CO2	2	3	-	-	-	-	2	-	3	2	-	-
CO3	2	2	-	-	-	-	2	-	2	1	-	-
CO4	3	3	-	-	-	-	1	-	3	2	-	-
CO5	3	1	-	-	-	-	1	-	3	3	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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**Effective from Session:** 2024-25

Course Code	B020604R/CH356	Title of the Course	Chemistry Research Project-2	L	T	P	C
Year	Third	Semester	Sixth	0	0	10	5
Pre-Requisite	Diploma	Co-requisite	-				
Course Objectives	To provide the industrial exposure and enhance technical skills of students						

Course Outcomes

CO1	Hands on training
CO2	Integrate classroom theory with laboratory practice.
CO3	Understanding professional ethics of industry and code of conduct.
CO4	Essential training in laboratory safety procedures
CO5	Compilation of data and report writing

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

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CO1	1	2	3	1	2	1	-	-	2	2	2	1
CO2	2	1	1	2	1	2	-	-	3	2	1	1
CO3	1	1	3	3	1	3	-	-	3	3	2	1
CO4	1	3	2	1	1	1	-	-	2	3	1	1
CO5	2	2	1	3	3	1	-	-	3	2	1	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**Name & Sign of Program Coordinator****Sign & Seal of HoD**