DEPARTMENT OF CHEMISTRY

Bachelor of Science

(Industrial Chemistry)

1st Semester As Per NEP-2020

Syllabi

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B190101T/CH131	**Title of the Course**	Fundamental of Industrial Chemistry	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	3	1	0	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	The purpose of this course is to impart basic and key knowledge of Indian ancient chemistry and fundamentals of chemical calculations; atomic structure; chemical bonding; organic compounds and nomenclature; liquid crystal and solid-state; metallurgical operations; metals and alloys; heat, thermodynamics, and chemical equilibrium. That is found to have a significant role in higher studies. After completing the course, the student will be able to explore subjects in their respective dimensions.						

Course Outcomes	
CO1	Students would get inside the sound knowledge of Indian ancient chemistry and essentials of chemical and also able to evaluate the atomic structure and their properties along with principles, shapes and electronic configurations.
CO2	Students are taught principles, types and strengths of various chemical combinations for effective application of bonding.
CO3	Evaluate the different types of organic reactions and their mechanism in a step-by-step manner.
CO4	Students would able to understand the chemistry of liquid crystal and solid state such as crystal lattices, laws of crystallography, crystal systems, unit cell and space lattice.
CO5	Students would able to understand the basic of metallurgical operations, metals and alloys as well as heat, thermodynamics and chemical equilibrium.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Indian Ancient Chemistry and Fundamentals of Chemical Calculations	Introduction of Indian ancient chemistry, contribution of Indian chemists in context to the holistic development of modern science and technology. Atomic weight, molecular weight, equivalent weight, mole concept, percentage yield, composition of liquid mixtures and gaseous mixtures, molarity, molality, normality.	6	1
2	Atomic Structure	Quantum numbers, Pauli exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, 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.	8	1
3	Chemical Bonding	Valence bond theory (VBT), concept of hybridization, hybrid orbitals and molecular geometry, valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, SF_6, PCl_5, SF_4, ClF_3, I_3, ClF_2 and SO_4 and H_3O^+, molecular orbital theory (MOT), molecular orbital diagrams bond orders of mononuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions).	8	2
4	Organic Compounds and Nomenclature	Classification, generic and trade names of organic compounds, functional group, aliphatic compound (alicyclic & cyclic), aromatic compound, heterocyclic compound, petroleum, natural gas, crude oil.	6	3
5	Fundamentals of Organic Chemistry and Catalysis	Cleavage of bonds (homolysis and heterolysis), reaction intermediates (carbocation, carbanion and free radicals), electrophiles and nucleophiles, aromaticity: benzenoids and Hückel's rule, inductive effect, electrometric effects, mesomeric effect, resonance, hyperconjugation and stearic effect, tautomerism, isomerism, elementary ideas of stereochemistry (geometrical and optical). Homogeneous and heterogeneous catalysis, basic principles, mechanisms, factors affecting the performance, enzyme catalysed reactions, industrially important reactions.	8	3
6	Liquid Crystal and Solid State	Classification and molecular arrangements, liquid state, density, diffusion, viscosity, evaporation, surface tension, effect of temperature and pressure on surface tension, parachor - definition and applications. Crystal lattices, laws of crystallography, crystal systems, unit cell, space lattice.	8	4
7	Metallurgical Operations, Metals and Alloys	Pulverization, calcination, roasting, refining, principles of extraction of metals, extraction of iron and copper from their ores. Important metals and alloys; mechanical and chemical properties of lead, nickel, iron, titanium and their alloys and their applications.	8	5
8	Heat, Thermodynamics and Chemical Equilibrium	Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, enthalpy changes, entropy, thermodynamic laws, processes and functions, free energy, partial molar quantities, activity, activity co-efficient, and fugacity, thermodynamic criteria and equilibrium constant, effect of temperature and pressure on equilibrium constants in gaseous system (formation of ammonia).	8	5

Reference Books:

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

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

Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education (2012).

Singh J.,Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition.

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

e-Learning Source:

https://swayam.gov.in/

https://nptel.ac.in/courses/112/104/112104113/

https://onlinecourses.nptel.ac.in/noc19_ph14/preview

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

https://ncert.nic.in/textbook.php?kech1=0-7

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B020101T /CH132	**Title of the Course**	Fundamental of Chemistry	**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 convey fundamental knowledge of weak chemical forces, molecular polarity, and periodic properties such as periodic trends, arising from the arrangement of the periodic table, providing chemists with an invaluable tool to quickly predict an element's properties, recapitulation of acids and bases, stereochemistry, organic reaction mechanisms, and organic fundamentals. 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 molecular polarity and weak chemical forces such as Van der Waals forces, ion-dipole forces, dipole dipole interactions and induced dipole interaction. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters.
CO2	Students got insight knowledge of periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements.
CO3	Students evaluate fundamentals of chemical reaction, reactive intermediates, transition states and states of all the bonds broken and formed. It enables to understand the reactants, catalyst, steriochemistry and major and minor products of any organic reaction.
CO4	Students would perceive the sound knowledge of stereochemistry that gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.
CO5	Students would able to difference between acids and bases with the help of various principles and also understand about the theories of indicators, acid-base, redox, metal ion and adsorption indicators and choice of indicators.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Molecular polarity and Weak Chemical Forces	Resonance and resonance energy, formal charge, 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. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	8	1
2	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, Allred and Rochow scale, diagonal relationship with examples, summary of horizontal, vertical and diagonal relationships in the periodic table.	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. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	8	2
4	Recapitulation of Basics of Organic Chemistry	Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clatherates, Charge transfer complexes, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications	6	3
5	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, Types of organic reactions, Energy considerations. Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	8	3
6	Stereochemistry-I	Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythro diastereomers, meso compounds, resolution of enantionmer, inversion, retention and recemization. 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	Acids and Bases	Lowery - Bronsted concept, Lewis 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	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., 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/
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**

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B190102P/CH133	**Title of the Course**	Basic Analytical Methods	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	0	0	4	2
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	The purpose of the chemistry lab program in this course at Integral University is to provide the key knowledge of good laboratory practice (GLP), calibration apparatus, preparation of standard solutions, solutions of various concentrations, determination of viscosity, the surface tension of liquids, and simple laboratory techniques.						

Course Outcomes	
CO1	Students are able to understand and performed good laboratory practice (GLP).
CO2	Understand the basic analytical and technical skills to work effectively in the various fields of chemistry.
CO3	Remember to keep records of all performed experiments in the manner which is required in laboratory.
CO4	Able to determine the viscosity and surface tension of liquids.
CO5	Able to preparation of standard solutions and solutions of various concentrations.

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	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
4	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. Preparation of standard $KMnO_4$ and ferrous ammonium sulphate solution. To find out the strength of unknown ferrous ammonium sulphate solution using as an intermediate.	15	5

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 Cl 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	3	-	-	-	-	-	-	3	2	1	2
CO2	1	2	-	-	-	-	-	-	2	1	2	3
CO3	3	3	-	-	-	-	-	-	3	2	1	2
CO4	3	1	-	-	-	-	-	-	2	3	1	3
CO5	2	3	-	-	-	-	-	-	3	2	1	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: 2022-2023							
Course Code	B020102P/CH134	**Title of the Course**	Quantitative Analysis	**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 at Integral University is designed to give students the essential knowledge of laboratory techniques and tests for estimating metal ions, estimating the concentrations of acids and alkalis in commercial products, and evaluating the portability of water samples.						

Course Outcomes	
CO1	Students have the knowledge and skills to understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products.
CO2	Understand and perform the portability tests of water samples.
CO3	Perform estimation of metals ions.
CO4	Perform estimation of alkali and acid contents in samples.
CO5	Perform estimation of inorganic salts and hydrated water in samples.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Estimation of one Anion and Cation	Estimation of one anion and cation in a given salt: Anion: CO_3^{2-}, S^{2-}, SO_3^{2-}, SO_4^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, PO_4^{3-}, $C_2O_4^{2-}$, 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_3^+	15	1,2
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 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

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
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CO2	2	3	-	-	-	-	-	-	3	2	1	3
CO3	3	2	-	-	-	-	-	-	2	1	1	2
CO4	2	3	-	-	-	-	-	-	3	2	2	3
CO5	3	1	-	-	-	-	-	-	3	3	1	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: 20222-2023							
Course Code	B190103T/CH135	**Title of the Course**	Water Treatment and Analysis	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	3	1	0	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course aims to familiarize students with the field of water and wastewater treatment. The course will cover sludge disposal, primary, secondary, and tertiary treatment processes; water chemistry; characteristics of water and wastewater; and the design of water and wastewater treatment plants; cleaner water production; and most favorable treatment technologies.						

Course Outcomes	
CO1	Identify the parameters that define the constituents of potable water and wastewater; demonstrate the fundamentals of water and wastewater treatment.
CO2	Able to explain the function and procedural procedures of important water treatment processes, such as coagulation, precipitation, chlorination, etc., used to improve water quality.
CO3	Understand the typical physical, chemical, and biological unit activities used in treatment procedures, and investigate the biological characteristics of water. The operating procedures of treatment systems to handle trash from homes and businesses are examined.
CO4	Students become aware of the potentially dangerous effects of waste on the environment and human health. A sense of sustainable environmental measures is developed via the evaluation of various corrective actions to quantify waste amount and strength.
CO5	To get rid of hazardous trash, awareness will be raised regarding waste generation, its effects, and mitigation techniques. The use of environmental audits in industries would result from keeping in mind their key components.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Industrial pollution	Types of industries and industrial pollution; Characteristics of industrial wastes; Population equivalent; Bioassay studies; effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health; Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.	6	1
2	Purification of Water for Drinking Purpose	Clarification, coagulation, contact & electro chemical coagulation, sterilization & disinfections of water, precipitation, aeration, ozonisation and Chlorination.	8	1,2
3	Determination of Hardness and Softening Methods for Water	Determination of hardness of water: Titration methods - complexometric method using EDTA. Water softening methods: lime soda process, permutit or zeolite process, Ion exchange process or demineralization of water, Desalination of water: elecrodiaysis and Reverse osmosis.	8	2,3
4	Water Analysis	Water analysis: sampling of water for analysis - chemical substances affecting potability - colour, turbidity odour, taste, temperature, pH and electrical conductivity. Analysis of solids present in water: suspended solids, dissolved solids, total acidity, alkalinity, free CO2, and free chlorine.	6	2,3
5	Analysis of Chemical Substances Affecting Health	Analysis of chemical substances affecting health: Ammonia, Nitrate, Nitrite, cyanide, sulphate, sulphide, chloride, fluoride. Analysis of chemical substances indicative of pollution: Dissolved oxygen, Bio Chemical oxygen demand (BOD), Chemical oxygen demand (COD).	8	4
6	Bacteriological Examination of Water	Bacteriological examination of water: total count test; E.coli test, E.coli index, most probable number method, Biological examination of water.	8	1,5
7	Cleaner Water Production	Waste management Approach; Waste Audit; Volume and strength reduction; Material and process modifications Recycle, reuse and byproduct recovery; Applications.	8	4
8	Treatment Technologies	Equalisation; Neutralisation; Removal of suspended and dissolved organic solids; Chemical oxidation, Adsorption Removal of dissolved inorganics; Combined treatment of industrial and municipal wastes; Residue management; Dewatering; Disposal.	8	1,5

Reference Books:

Chemical Thermodynamics by R.P.Rastogi et al

Principles of physical chemistry by Puri Sharma and Pathan

Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.

e-Learning Source:

https://condorchem.com/en/industrial-wastewater-treatment/

https://www.chemicalprocessing.com/articles/2018/understand-industrial-wastewater-treatment/

https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/industrial-waste-treatment

	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	1	1	2	3
CO2	3	2	-	-	-	-	-	2	1	1	2	3
CO3	2	2	-	-	-	-	-	2	1	1	2	2
CO4	3	3	-	-	-	-	-	3	1	1	2	3
CO5	2	3	-	-	-	-	-	3	1	1	2	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: 2022-2023							
Course Code	B190104P/CH136	**Title of the Course**	Water Quality Analysis	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	3	1	0	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	Students will possess the practical, technical, communicative, and conceptual knowledge necessary to solve both qualitative and quantitative problems as well as transferrable abilities like the capacity to work both individually and in teams. They will also be able to work efficiently and safely in a laboratory environment.						

Course Outcomes	
CO1	To work effectively in the various domains of chemistry, keep records of all experiments you perform in the manner required in the lab. You should also be aware of the fundamental analytical and technical abilities needed.
CO2	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO3	Able to evaluate water quality parameters like DO, BOD, COD, TDS and alkalinity.
CO4	Students should be aware of how to measure the amount of alkali in antacid tablets.
CO5	Analyze the chloride content in the water sample and also the percent chlorine in the bleaching powder sample.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Standard and buffer solution	Preparation of standard solution related to normality & molarity. Preparation of buffer solution, pH measurement.	15	1,2
2	Water quality parameters	Estimation of hardness of water by EDTA. Determination of Dissolved oxygen (DO) in the given water sample. Determination of chemical oxygen demand (COD). Determination of Biological oxygen demand (BOD).	15	1,2,3
3	Total dissolved solid and total alkali content	Determination of Total dissolved solid (TDS) in the given water sample. Determination of alkali content in antacid tablet using HCl.	15	1,2,3,4
4	Chloride content	Determination chloride content in the given water sample. Determination the percentage of available chlorine in the given bleaching powder sample.	15	1,2,5

Reference Books:

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.

Practical Organic Chemistry, A.I.Vogel.

Practical Physical Chemistry: B. Viswanathan and P.S.Raghavan.

Experimental Inorganic Chemistry –W.G.Palmer.

e-Learning Source:

https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf

http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf

https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf

https://www.stem.org.uk/resources/collection/3959/practical-chemistry

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-2023							
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**

Integral University, Lucknow

Effective from Session: 2022-23							
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 alongwith 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 micro nutrients and its RDA, sources, functions, deficiency and excess.
CO3	To learn 1000 days Nutrition Concept and study the nutritive requirement during special conditions like pregnancyand 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, PotassiumTrace: 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 daysNutrition	(a) Concept, Requirement, Factors affecting growth of child (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirementand 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 Nutritionrequirement in the following: Diabetes Hypertension (High Blood Pressure)Obesity ConstipationDiarrhea Typhoid (b) National and International Program and Policies for improving DietaryNutrition (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**

DEPARTMENT OF CHEMISTRY

Bachelor of Science

(Industrial Chemistry)

2nd Semester As Per NEP-2020

Syllabi

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B190201T/CH138	**Title of the Course**	Material Science and Techniques in Chemical Industries	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	3	1	0	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course aims to educate fundamental and essential understanding of cutting-edge materials for use in environmental applications. The implications of these cutting-edge materials and their applications on the environment, security, the recycling and reuse of raw materials and treatment agents, economic gains, and potential societal issues have all been studied in detail. Students who successfully complete this theory course will have an understanding of various materials, surface chemistry and interfacial phenomena, catalysis, advanced materials, and material balance, both material balances with and without chemical reactions. Pharmaceuticals and X-ray powder diffraction; distillation, evaporation, and absorption; filtering, extraction, and drying; and organic chemical purification are all examples of crystallization.						

Course Outcomes	
CO1	Students would get sound knowledge of various materials along with the material balance without chemical reactions and with chemical reactions.
CO2	Students would be able to understand surface chemistry and ceramics.
CO3	Students would restate a brief idea about water, steam, and air boilers used in chemical industries along with crystallization.
CO4	Students would be able to understand the basic definitions and terms in X-ray powder diffraction and pharmaceuticals along with the Distillation, evaporation and absorption processes.
CO5	The basics and principles of filtration, extraction, and drying would be clear to the students. They are renowned for using a variety of techniques to purify organic molecules.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	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.	6	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	2
3	Utilities in Chemical Industry	A brief idea about water, steam and air boilers used in chemical industries. A brief idea about fans, blowers, compressors and vacuum pumps, reciprocating pumps, gear pumps, centrifugal pumps, ejectors used in chemical industries.	8	3
4	Crystallization	Equilibrium solubility, super saturation, definition, nucleations, crystallization, equipment-tank crystallizer and circulating liquid evaporator crystallizer.	6	3
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.	8	4
6	Distillation, Evaporation and Absorption	Batch and continuous distillation, azeotropic and extractive distillation. Evaporator equipments; short tube evaporator and forced circulation evaporators. Equipments: Tray (Plate) towers for absorption, packed towers for absorption.	8	4
7	Filtration, Extraction and Drying	Filter media and filter aids, filtration equipment- bed filters, plate and frame press filters, rotary drum filter and centrifuges. Extraction equipments: spray column and packed column extraction, rotating disc column extractors, liquid-liquid extraction, acid-base extraction. Purpose of drying, equipment- tray dryer, rotary dryer, flask dryer, fluid bed dryer, drum dryer, spray dryer.	8	5
8	Purification of Organic Compounds	Simple crystallization, fractional crystallization, sublimation, simple distillation, fractional distillation, distillation under reduced pressure, steam distillation, azeotropic distillation.	8	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. L. Mc. Cabe, J. C. Smith & Parriet Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore, 7th edition (2017)

W. D. Callister Jr., D. G. Rethwisch Materials Science and Engineering: An Introduction, John Wiley & Sons (2018) .

e-Learning Source:

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://authors.library.caltech.edu/25034/10/BPOCchapter9.pdf (purification) chemistry-europe.onlinelibrary.wiley.com/journal/23656549

https://link.springer.com/content/pdf/10.1007/s41745-017-0026-4.pdf file:///C:/Users/dell/Downloads/144_Sample-Chapter.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	1	-	-	-	-	-	2	-	-	2	1
CO2	1	3	-	-	-	-	-	2	-	-	3	3
CO3	2	3	-	-	-	-	-	3	-	-	2	2
CO4	3	2	-	-	-	-	-	1	-	-	3	3

CO5	3	3	-	-	-	-	-	3	-	-	2	3

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B020101T /CH139	**Title of the Course**	Bioorganic and Materials 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 theoretical and experimental understanding of carbohydrates, amino acids, proteins, nucleic acids, and medicinal chemistry along with the solid state, basic chemical calculation, units and dimensions, material balance, energy balance, and the basics of medicinal chemistry.						

Course Outcomes	
CO1	To understand that biomolecules are important for the functioning of living organisms and also the chemistry of carbohydrates.
CO2	Students are 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	Students understand the fundamentals of solid state chemistry like space lattice, unit cell, laws of crystallography and X-ray diffraction by crystals.
CO4	Students would be able to understand the basic chemical calculations, units and dimensions, material balance and energy balance.
CO5	Students would get in-depth sound knowledge of medicinal chemistry such as antibiotics, antipyretics, analgesics, antimalerials, and cardiovascular drugs.

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	Solid State	Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (powder method).	8	3
5	Basic Chemical Calculation, Units and Dimensions	Introduction, Concept of atom, Mole and mole fraction, Methods of expressing the composition of mixtures (mass percent, volume percent, mole percent), equivalent weight, normality, molarity, molality. Introduction, Dimensions & Systems of Units, Fundamental quantities, Derived Quantities, Conversions & Problems.	8	4
6	Material Balance	Process classification, Choice of system and basis of molecular processes with chemical reactions, Material balance calculations, multiple unit processes, Recycle and bypass.	6	4
7	Energy Balance	Energy balance: Forms of energy, Energy balance, Energy changes in physical processes, Energy changes in reactions, Energy balance Calculations.	6	4
8	Medicinal Chemistry	Evaluation and study of introduction, examples and uses of various antibiotics, antipyretics and analgesics, antimalerials and cardiovascular drugs.	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.

Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.

e-Learning Source:

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

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

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https://nptel.ac.in/courses/104/103/104103121/

	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	-	-	1	3
CO2	3	2	-	-	-	-	-	2	-	-	2	2
CO3	3	3	-	-	-	-	-	3	-	-	2	2
CO4	2	1	-	-	-	-	-	1	-	-	1	3

CO5	3	3	-	-	-	-	-	3	-	-	2	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: 2022-2023							
Course Code	B190102P/CH140	**Title of the Course**	Materialistic Analysis	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	0	0	4	2
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This lab course's main goal is to teach students the fundamentals of creating solutions of various concentrations, calculating concentrations, extracting compounds from solutions, determining materials' refractive indices, understanding molar and specific reactivity of solutions, and performing chromatographic separations.						

Course Outcomes	
CO1	Students would gain knowledge of preparing solutions of various concentrations, determination of concentrations, extraction of compounds from solutions.
CO2	Understand the basic analysis of solution molecular weight determination.
CO3	Able to perform extraction process.
CO4	Able to analyze refractive index of a liquid by using Abbe's Refractometer
CO5	Understand and perform various chromatography techniques such as column, paper and thin layer.

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.	15	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.	15	1,3
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.	15	1,4
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.	15	1,5

Reference Books:

A.I. Vogel, A.R. Tatchell, B.S. Furnis ,A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic chemistry (1989)

B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell,. Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).

G. Svehla, Vogel's Qualitative Inorganic Analysis, 7e Pearson (2008).

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

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

e-Learning Source:

https://fac.ksu.edu.sa/sites/default/files/vogel_-_practical_organic_chemistry_5th_edition.pdf

http://faculty.chas.uni.edu/~manfredi/860-121/ORG%20LAB%20MAN%20S08.pdf

https://www.ipinnovative.com/media/open-access-books/Practical_Lab_Manua l_of_Pharmaceutical_Organic_Chemistry_-1_ Low.pdf

https://gtu.ge/Agro-Lib/Vogels_Textbook_Of_Quantitative_Chemical_Analysis_ 5th_ed -_G_H_Jeffery.MsuCity.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	2	-	-	-	-	-	-	3	2	1	3
CO2	2	2	-	-	-	-	-	-	2	3	1	2
CO3	2	3	-	-	-	-	-	-	2	3	1	2
CO4	3	2	-	-	-	-	-	-	3	2	2	1
CO5	2	3	-	-	-	-	-	-	3	1	1	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: 2022-2023							
Course Code	B020102P/CH141	**Title of the Course**	Biochemical Analysis	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	0	0	4	2
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course aims to introduce students to the fundamental qualitative and quantitative experimental understanding of biomolecules, including simple drug creation and molecules made of carbohydrates, proteins, amino acids, and nucleic acids.						

Course Outcomes	
CO1	To develop the qualitative and quantitative experimental skills of biomolecules such as carbohydrates, proteins, amino acids, and nucleic acids.
CO2	To perform a qualitative and quantitative analysis of carbohydrates
CO3	To perform a qualitative and quantitative analysis of proteins, amino acids, and fats
CO4	To determine and identify nucleic acids and their strength components.
CO5	Able to synthesize simple drug molecules.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	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
2	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
3	Determination and Identification of Nucleic Acids	Determination of nucleic acids Extraction of DNA from onion/cauliflower	15	1,4
4	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	1,5

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/

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http://chemcollective.org/vlabs

https://gtu.ge/Agro-Lib/Vogels_Textbook_Of_Quantitative_Chemical_Analysis_ 5th_ed -_G_H_Jeffery.MsuCity.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	3	-	-	-	-	-	-	3	2	1	2
CO2	3	2	-	-	-	-	-	-	3	3	1	1
CO3	3	3	-	-	-	-	-	-	2	2	2	2
CO4	2	3	-	-	-	-	-	-	3	1	1	2
CO5	3	3	-	-	-	-	-	-	2	2	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: 2022-2023							
Course Code	B190203T/CH142	**Title of the Course**	Inorganic Chemical Process Industry	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	3	1	0	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course's goal is to familiarize students with various industrial processes. The course will cover leather and textile chemistry, glass, industrial carbon, ceramics and refractories, pulp and paper, special types of papers and their production processes, and ceramics and refractories.						

Course Outcomes	
CO1	Understand the composition of glass and their types, properties and uses.
CO2	Understand the classification, properties and uses of ceramics and refractories and their respective characteristics.
CO3	Students will be able to apply the knowledge to produce various types of pulp and papers and also know the processing techniques to produce special types of papers.
CO4	Student will be able to demonstrate the basic mechanism and processes involved in leather industry and also know about a challenge which arises from leather industries and their handling.
CO5	Student will able to know about Indian textile industries and products.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Glass	Introduction, Classification and General Properties of Glass, Characteristics, raw Materials, Chemical Reactions, Methods of Manufacture and Uses.	6	1
2	Industrial Carbon	Lampblack, Carbon Black, Activated Carbon, Natural Graphite, Manufactured Graphite and Carbon, Industrial Diamonds.	8	2
3	Ceramics and Refractories	Introduction, Types of ceramics materials, properties and applications. Refractories, classification of refractories, characteristics of refractories materials, properties of refractories. Neutral refractories; Silicon carbide. Acid refractories; High Alumina refractories.	8	2
4	Pulp and Paper	Introduction - Manufacture of pulp, Sulphate or Kraft pulp, Soda pulp, Sulphite pulp Rag pulp, Beating, refining, filling, sizing and coloring , manufacture of paper and paper making additives; processing aids, functional additives, strength additives and binders.	6	3
5	Special Types of Papers and their Manufacturing Process	Ammonia paper, Art paper, Bituminized water proof paper, Emery Paper, Toilet paper, Wall paper , Wax coated paper and polymeric modified papers	8	3
6	Leather Industry-I	Introduction - Constituents of Animal Skin - Preparing skins and hides - Cleaning and soaking - Liming and degreasing.	8	4
7	Leather Industry-II	Introduction, Manufacture of leather, Preparation of hides for tanning, Vegetable, chrome and oil tanning - Byproduct.	8	4
8	Textiles Chemistry	Indian textile industries, general consideration of textile fibres: cotton, wool, silk, and rayon fibres; General considerations of synthetic fibres; Indetification of textile fibres; Water soluble resins, and epoxy resins.	8	5

Reference Books:

Shreve R.N. Brink. J.A., Chemical Process Industries, International student edition, Pubs: McGraw Hill Book Co. New York, 1960.

Groggins P.M., Unit Process in Organic Synthesis, 5th edition, International student edition, Pubs: McGraw-Hill Book Co., New York, 1998.

Dryden's outlines of Chemical Technology, edited and revised by Gopala Rao M. and Marshall S, Pubs: East-West Press, New Delhi, 2004.

Industrial Chemistry B.K.Sharma, goel publishing house.

Chemical process principales: part 1 & II – O.A / Hougen, K.M Watson RA Ragatz (CBS)

e-Learning Source:

https://encyclopedia2.thefreedictionary.com/chemical+process+industry

https://www.youtube.com/watch?v=RjZJjneJ5fk

https://www.chemicalprocessing.com/

https://authors.library.caltech.edu/25034/10/BPOCchapter9.pdf (purification) chemistry-europe.onlinelibrary.wiley.com/journal/23656549

https://www.britannica.com/science/phosphorus-chemical-element

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	B190204P/CH143	**Title of the Course**	Titrimetric Analysis	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	0	0	4	2
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course is designed to introduce students to the fundamentals of various methods of titration, including acidimetry, alkalimetry, relaxometry, iodometric, complexometric, and argentometric titration. Students also understand titrimetric analysis to work effectively in the various fields of chemistry and also understand the basic titration methods and technical skills to work in the different fields of chemistry. Remember to keep records of all performed experiments in the manner which is required in the laboratory. Analyze the importance of personal safety and care of equipment and chemicals.						

Course Outcomes	
CO1	Students understand titrimetric analysis to work effectively in the various fields of chemistry
CO2	Able to know about the fundamentals of various methods of titration, including acidimetry, alkalimetry, relaxometry, iodometric, complexometric, and argentometric titration.
CO3	Understand the basic titration methods and technical skills to work in the different fields of chemistry.
CO4	Remember to keep records of all performed experiments in the manner which is required in the laboratory.
CO5	Analyze the importance of personal safety and care of equipment and chemicals.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Acidimetry and Alkalimetry Titration	Determination of the strength of NaOH and Na_2CO_3 present together in a solution. Determination of the strength of Na_2CO_3 and $NaHCO_3$ present together in a solution.	15	1,2
2	Relaxometric Titration	Determination of the strength of oxalic acid solution. Determination of the strength of ferrous ammonium sulphate (Mohr's salt) solution. Determination of the strength of calcium in an calcium chloride solution.	15	1,3
3	Iodometric Titration	Determination of the strength of copper solution iodometrically. Determination of the strength of potassium dichromate solution. Determination of the strength of potassium permanganate solution.	15	1,4
4	Complexometric and Argentometric Titration	Estimation of the Calcium with EDTA. Estimation of the Magnesium with EDTA. Determination of the strength of a Silver nitrate solution by Mohr's method.	15	1,5

Reference Books:

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.

Practical Organic Chemistry, A.I.Vogel.

Practical Physical Chemistry: B. Viswanathan and P.S.Raghavan.

Experimental Inorganic Chemistry –W.G.Palmer.

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.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf

http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf

https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf

https://www.stem.org.uk/resources/collection/3959/practical-chemistry

	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	3	-	-	-	-	-	-	3	2	1	2
CO2	3	2	-	-	-	-	-	-	3	3	1	1
CO3	3	3	-	-	-	-	-	-	2	2	2	2
CO4	2	3	-	-	-	-	-	-	3	1	1	2
CO5	3	3	-	-	-	-	-	-	2	2	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: 2022							
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 if 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:

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

e-Learning Source:

1. 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**

Integral University, Lucknow

Effective from Session: 2022							
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

	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	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**

Integral University, Lucknow

Effective from Session: 2022-2023							
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	This course's main objective is to give students a foundational 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	Recognize how to perform safety procedures in a science laboratory with great skill in sample handling.
CO2	Students would be capable of managerial skills in minimizing waste.
CO3	Understand the fundamentals of elementary knowledge of chemistry.
CO4	Capable of working with laboratory instruments, reagents, and solutions.
CO5	Students understand the expertise in handling sophisticated instruments for any pharma/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, percent 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**

Integral University, Lucknow

Effective from Session: 2022-2023							
Course Code	Z020201/NS110	**Title of the Course**	First Aid and Health	**L**	**T**	**P**	**C**
Year	First	**Semester**	Second	2	0	0	2
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	This course aims to educate fundamental and essential understanding of first aid and sex education.						

Course Outcomes	
CO1	Learn the skill needed to assess the ill or injured person and learn the skills to provide CPR to infants, children and adults.
CO2	Learn the skills to handle emergency child birth and learn the Basic sex education help young people navigate thorny questions responsibly and with confidence.
CO3	Learn the Basic sex education help youth to understand Sex is normal. It's a deep, powerful instinct at the core of our survival as a species. Sexual desire is a healthy drive.
CO4	Help to understand natural changes of adolescence
CO5	Learn the skill to identify Mental Health status and Psychological First Aid

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of First Aid-I	A. Basic First Aid • Aims of first aid & First aid and the law. • Dealing with an emergency, Resuscitation (basic CPR). • Recovery position, Initial top to toe assessment. • Hand washing and Hygiene • Types and Content of a First aid Kit B. First AID Technique • Dressings and Bandages. • Fast evacuation techniques (single rescuer). • Transport techniques. C. First aid related with respiratory system • Basics of Respiration • No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging, • Swelling within the throat, Suffocation by smoke or gases and Asthma. D. First aid related with Heart, Blood and Circulation • Basics of The heart and the blood circulation. • Chest discomfort, bleeding. E. First aid related with Wounds and Injuries • Type of wounds, Small cuts and abrasions • Head, Chest, Abdominal injuries • Amputation, Crush injuries, Shock F. First aid related with Bones, Joints Muscle related injuries • Basics of The skeleton, Joints and Muscles. • Fractures (injuries to bones).	8	1,2
2	Fundamentals of First Aid-II	G. First aid related with Nervous system and Unconsciousness • Basics of the nervous system. • Unconsciousness, Stroke, Fits – convulsions – seizures, Epilepsy. H. First aid related with Gastrointestinal Tract • Basics of The gastrointestinal system. • Diarrhea, Food poisoning. I. First aid related with Skin, Burns • Basics of The skin. • Burn wounds, Dry burns and scalds (burns from fire, heat and steam). • Electrical and Chemical burns, Sun burns, heat exhaustion and heatstroke. • Frost bites (cold burns), Prevention of burns, Fever and Hypothermia. J. First aid related with Poisoning • Poisoning by swallowing, Gases, Injection, Skin K. First aid related with Bites and Stings • Animal bites, Snake bites, Insect stings and bites L. First aid related with Sense organs • Basic of Sense organ. • Foreign objects in the eye, ear, nose or skin. • Swallowed foreign objects. M. Specific emergency satiation and disaster management • Emergencies at educational institutes and work • Road and traffic accidents. • Emergencies in rural areas. • Disasters and multiple casualty accidents. • Triage. • Emergency Child birth	8	2.3
3	Fundamentals of Sex Education-I	Basic Sex Education • Overview, ground rules, and a pre-test • Basics of Urinary system and Reproductive system. • Male puberty — physical and emotional changes • Female puberty — physical and emotional changes • Male-female similarities and differences	7	4

		• Sexual intercourse, pregnancy, and childbirth • Facts, attitudes, and myths about LGBTQ+ issues and identities • Birth control and abortion • Sex without love — harassment, sexual abuse, and rape • Prevention of sexually transmitted diseases.		
4	Fundamentals of Sex Education-II	• Mental Health and Psychological First Aid • What is Mental Health First Aid? • Mental Health Problems in the India • The Mental Health First Aid Action Plan • Understanding Depression and Anxiety Disorders • Crisis First Aid for Suicidal Behavior & Depressive symptoms • What is Non-Suicidal Self-Injury? • Non-crisis First Aid for Depression and Anxiety • Crisis First Aid for Panic Attacks, Traumatic events • Understanding Disorders in Which Psychosis may Occur • Crisis First Aid for Acute Psychosis	7	5

Reference Books:
Indian First Aid Mannual-https://www.indianredcross.org/publications/FA-manual.pdf
Red Cross First Aid/CPR/AED Instructor Manual
https://mhfa.com.au/courses/public/types/youthedition4
Finkelhor, D. (2009). The prevention of childhood sexual abuse. Durham, NH: Crimes Against Children Research Center.
Orenstein, P. (2016). Girls and sex: Navigating the complicated new landscape. New York, NY: Harper.
e-Learning Source:
https://www.redcross.org/take-a-class/first-aid/first-aid-training/first-aid-online
www.unh.edu/ccrc/pdf/CV192. pdf
https://www.firstaidforfree.com/
https://www.coursera.org/learn/psychological-first-aid
https://www.coursera.org/learn/mental-health

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190401T/CH238	**Title of the Course**	Process Chemistry	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	3	1		4
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students gain knowledge and skills in various organic chemistry processes, including nitration, sulphonation, halogenation, oxidation, hydrogenation, alkylation, ammination, esterification, and hydrolysis. Pharmaceuticals, drug molecules, and other industrially significant organic compounds are synthesized using these organic chemical processes.						

Course Outcomes	
CO1	Students understand the mechanisms and examples of nitration and halogenation reactions on various compounds such as paraffin hydrocarbons, benzene, chlorobenzene, acetanilide, and toluene; learning about nuclear and side chain halogenations, introduction to nitrating agents and halogenation reagents, and commercial production of chlorobenzene, chloral, monochloroacetic acid, and chloromethanes.
CO2	Students know sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, and alkylbenzene.
CO3	Students understand the types of oxidation reactions, oxidizing agents, mechanism of oxidation of naphthalene, phthalamide and anthracene, liquid phase oxidation and vapour phase oxidation, commercial manufacture of benzoic acid, maleicanhydride, phthalic anhydride, acetaldehyde, acetic acid.
CO4	Students understand the thermodynamics and catalysts involved in hydrogenation reactions, the production of methanol from carbon monoxide and hydrogen, and catalytic reforming, as well as the types of alkylation, alkylating agents, and the mechanism behind alkylation reactions, leading to the manufacture of phenyl ethyl alcohol and alkyl benzenes for detergent production.
CO5	Students will have gained knowledge on the principles and mechanisms of esterification, hydrolysis, reduction, and aminolysis reactions, including practical applications such as the commercial manufacture of various chemicals using these reactions.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Nitration	Introduction, nitrating agents, mechanism, and nitration of paraffin hydrocarbons - benzene to nitrobenzene and m-dinitrobenzene, chlorobenzene to o- &p- nitro chlorobenzenes, acetanilide to p-nitro acetanilide and toluene.	8	1
2	Halogenation	Introduction, reagents for halogenations, halogenations of aromatics-side chain and nuclear halogenations, commercial manufacture of chlorobenzene, chloral, monochloroacetic acid and chloromethanes.	8	1
3	Sulphonation	Introduction, sulphonating agents, chemical and physical factors in sulphonation, mechanism of sulphonation, commercial sulphonation of benzene, naphthalene, alkylbenzene.	7	2
4	Oxidation	Introduction, types of oxidation reactions, oxidizing agents, mechanism of oxidation of naphthalene, phthalamide and anthracene, liquid phase oxidation and vapour phaseoxidation, commercial manufacture of benzoic acid, maleicanhydride, phthalic anhydride, acetaldehyde, acetic acid.	7	3
5	Hydrogenations	Introduction, thermodynamics of hydrogenation reactions, catalysts for hydrogenation reactions, hydrogenation of vegetable oils, manufacture of methanol from carbon monoxide and hydrogen, catalytic reforming.	7	4
6	Alkylation	Introduction, types of alkylation, alkylating agents, thermodynamics and mechanism of alkylation reactions, manufacture of phenyl ethyl alcohol and alkyl benzenes (for detergent manufacture).	7	4
7	Esterification and Hydrolysis	Introduction, esterification reactions by organic acids, commercial manufacture of ethyl acetate, vinyl acetate, cellulose acetate. Introduction, hydrolyzing agents, mechanism of hydrolysis.	8	5
8	Amination	i. By reduction: Introduction, methods of reduction, metal and acid, catalytic sulfide, electrolytic, metal and alkali sulfites, metal hydrides, sodium metal, conc. caustic oxidation- reduction, commercial manufacture of aniline, m-nitroaniline, p-aminophenol. ii. By aminolysis: Introduction, aminating agents, factors affecting.	8	5

Reference Books:

R. N. Morrison & R. N. Boyd, Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

P. A. Sykes, Guidebook to Mechanism in Organic Chemistry, Pearson Education (2003).

F. A. Carey, Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education (2012).

G. M. Loudo, Organic Chemistry, Fourth edition, Oxford University Press,2008.

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

T.W. Graham Solomons& C. B. Fryhle, Organic Chemistry, John Wiley & Sons, Inc.

J. G. Smith, Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.

J. March, Advanced Organic Chemistry, Fourth edition, Wiley.

Alok Kumar Srivastava, "Organic Chemistry-II", Mahaveer Publication, Dibrugarh, Assam, India (2021).

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/104/103/104103071/#

https://swayam.gov.in/

https://www.youtube.com/watch?v=Gzk21Q_fV88

	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	1	2	2	-	-	-	-	-	-	-	-	1	-	-	1	2
CO2	2	2	2	1	-	-	-	-	-	-	-	-	2	-	-	2	1
CO3	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-	1	2
CO4	3	2	2	2	-	-	-	-	-	-	-	-	1	-	-	1	2
CO5	3	1	1	2	-	-	-	-	-	-	-	-	2	-	-	2	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: 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	1H-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 cycloprpanone, 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,4 theditionWiley Eastern Ltd ,2001; Atkins,PW,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; Rl Madan, Chemsitry 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 Chemsitry, 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; Tn Srivastva And Pc Kampoj, Systematic Nalytical 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://heecontent.upsdc.gov.in/Home.aspx

https://nptel.ac.in/courses/104/108/104108078/

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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 Correlation1

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190402P/CH240	**Title of the Course**	Qualitative and Synthetic Methods	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth			4	2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students gain knowledge and skills related to this paper as follows: Utilities in the chemical industry include distillation, evaporation, and absorption; filtration and extraction; drying; crystallization and polymorphism; fluid flow; and heat transfer.						

Course Outcomes	
CO1	Student become able to determination of the flash point, ignition point of liquids, and smoke point of a fuel.
CO2	Students can analyze nitration, sulphonation, Friedel-Crafts reaction, esterification, hydrolysis, oxidation, halogenation, chlorosulphonation, reduction, and amination.
CO3	Each step of the reaction is monitored by TLC. 4-Bromo aniline, 3-Nitroaniline, Sulphanilamide, 4-Amino benzoic acid, 4-Nitro benzoic acid, Dihalobenzenes, Nitrohalobenzenes
CO4	Students can monitor chemical reactions with the help of TLC.
CO5	To perform limit tests for chlorine, arsenic, and heavy metals (Pb, As, Hg, Fe, and ash content) identification.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Analysis of fuel	Determination of the flash point, ignition point of liquids, and smoke point of a fuel.	10	1
2	Chemical process	One or two examples of each of the following unit processes Nitration, sulphonation, Friedel-Crafts reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation, reduction, and amination	15	2, 3
3	Synthesis of common industrial compounds	TLC monitors each step of the reaction. 4-Bromo aniline, 3-Nitroaniline, Sulphanilamide, 4-Amino benzoic acid, 4-Nitro benzoic acid, Dihalobenzenes, Nitrohalobenzenes	20	4
4	Limit tests	Limit tests for chlorine, arsenic, and heavy metals (Pb, As, Hg, Fe, and ash content)	15	5

Reference Books:

A.I. Vogel, A.R. Tatchell, B.S. Furnis , A.J. Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic chemistry(1989).

B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).

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).

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

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

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**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	2	1	2	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	-	2	1	-	-
CO3	2	3	1	1	-	-	-	-	-	-	-	-	-	1	2	-	-
CO4	2	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	-	1	1	-	-

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

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 $KMnO_4$/$K_2Cr_2O_7$ 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. &Chalmes, R.A. Laboratory Handbook of Chromatographic &AlliedMethods, 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=ygUcc3BlY3Ryb3Bob3RvbWV0ZXIgZXhwZXJpbWVudA%3D%3D

https://www.youtube.com/watch?v=LbsNI3WgUso&pp=ygUMc3BlY3Ryb3Njb3B5

	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**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190403T/CH242	**Title of the Course**	Industrial Waste Treatment & Management	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	3	1		4
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Basic knowledge of industrial waste management technologies, acquaintance with basic waste treatment technologies and environmental legislations to curb hazardous wastes will be taught to students.						

Course Outcomes	
CO1	Students understand sources, characteristics, and waste treatment flow sheets for selected industries such as textiles, tanneries, pharmaceuticals, dairy, sugar, paper, distilleries, steel plants, and thermal power plants; wastewater reclamation concepts.
CO2	Students understand physical and chemical treatment, solidification, incineration, and secure landfills. Types of waste, management of solid waste, treatment, and disposal of non- toxic solid waste (landfills, scrubbing, flue gas cleaning, incineration, heat drying, wet oxidation, biodegradation, etc.), treatment of hazardous waste, and e-waste treatment.
CO3	Students know heavy metals, biosorption by fungi, algae, and bacteria; factors affecting biosorption; bioreactors for biosorption: packed bed reactor, fluidized bed reactor, rotating disc reactor, sequential reactor.
CO4	Student will be able to understand biotechnological applications for environmental management cover various areas, including composting, carbon sequestration, bioenergy and biofuels, anaerobic digestion for methane production, as well as the assessment and feasibility of industrial pollution prevention, waste management, and recycling, waste disposal by incineration, and ultimate disposal.
CO5	Students will be understand the toxic chemicals in the environment including fertilizers, insecticides, pesticides, plastics, toxic metals, dyes, surfactants, and their toxicity; international and national standards and control; biochemical effects of mercury and lead, carcinogens, vector-borne and water-borne diseases, pollution, and public health issues.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Pollution From Major Industries	Sources, characteristics, and waste treatment flow sheets for selected industries such as textiles, tanneries, pharmaceuticals, dairy, sugar, paper, distilleries, steel plants, and thermal power plants; wastewater reclamation concepts.	8	1
2	Hazardous Waste Management	Hazardous wastes: physical and chemical treatment, solidification, incineration, secures landfills.	7	2
3	Solid Waste Management	Types of waste, management of solid waste, treatment, and disposal of non-hazardous solid waste (landfills, scrubbing, flue gas cleaning, incineration, heat drying, wet oxidation, biodegradation etc.), treatment of hazardous waste, E-waste treatment.	8	2
4	Biosorption of Metals	Introduction, heavy metals, Biosorption by fungi, algae and bacteria, factors affecting biosorption, bioreactors for Biosorption- Packed bed reactor, fluidized bed reactor, rotating disc reactor, sequential reactor.	7	3
5	Biotechnological Intervention in Environmental Management	Biotechnological application to the management of the environment: composting, carbon sequestration, bioenergy and biofuels, anaerobic digestion for methane production, factors affecting biogas production.	8	4
6	Industrial Pollution Prevention	Assessment of Industrial Pollution Prevention, Feasibility of Industrial Pollution Prevention, Feasibility Implementation, Waste Management, Recycling, Waste Disposal by Incineration, Ultimate Disposal	8	4
7	Agricultural Pollutants	Fertilizers, insecticides, pesticides, plastics, toxic metals, dyes, surfactants, and their toxicity; international and national standards; control.	7	5
8	Chemical Toxicology	Toxic chemicals in the environment, biochemical effects of mercury and lead, carcinogens, vector-borne disease, water-borne disease, pollution, and public health issues.	7	5

Reference Books:

Chemical Thermodynamics by R.P.Rastogi et al; Simplified course in Physical Chemistry, Madan&Tuli, S. Chand & Co. Ltd.

Principles of physical chemistry by Puri Sharma and Pathan; Atkin's Physical Chemistry, Atkin, Oxford Press.

Essentials of Physical Chemistry, Bahl&Tuli, S. Chand & Co. Ltd.; Principles of Physical Chemistry, Puri, Sharma &Pathania, Vishal Publishing Co.

e-Learning Source:

https://condorchem.com/en/industrial-wastewater-treatment/; https://www.water.wa.gov.au/ data/assets/pdf_file/0008/4040/89343.pdf

https://www.chemicalprocessing.com/articles/2018/understand-industrial-wastewater-treatment/

https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/industrial-waste-treatment

	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																	
CO2																	
CO3																	
CO4																	
CO5																	

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190404P/CH243	**Title of the Course**	Industrial Waste Analysis	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth			4	2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students gain knowledge and skills related to this paper as follows: instrumental methods of analysis, material testing, water analysis, and use of transducers for measuring flow control, and flow measuring devices (floats).						

Course Outcomes	
CO1	Student will be able to determine phenolphthalein alkalinity, methyl alkalinity; total alkalinity, total hardness, calcium hardness, and acidity of the given water sample and express the results in moles per liter and mg/L as $CaCO_3$ for hardness parameters, and in equivalence/L and mg/L as CO_2 for acidity.
CO2	Student will be able to determine the available chlorine percentage, chloride content, and pH of the given chlorine solution sample and each water sample.
CO3	Student will be able to determine the dissolved oxygen, 3-day BOD, and COD of the given sample of water.
CO4	Student become able to measure the total solids (T.S.) and total dissolved solids (T.D.S.) as well as the conductivity of a given water sample.
CO5	Student will be able to determine the potassium content in the provided water sample and to measure the amount of matter present in the air.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Alkalinity determination	i. To determine phenolphthalein alkalinity, methyl alkalinity, and total alkalinity in the given sample. ii. To determine total hardness and calcium hardness in the given water. Express your result in moles per liter and mg/L as $CaCO_3$. iii. To determine the acidity of the given sample of water. Express your result in equivalence/L and mg/L as CO_2.	15	1
2	Chloride content determination	i. To determine the percentage of available chlorine in the given chlorine solution sample. ii. To determine the chloride content in each sample of water. iii. To determine the pH of the given sample of water.	15	2, 3
3	DO, BOD, and COD	i. To determine the dissolved oxygen in the given sample of water. ii. To determine the 3-day BOD of the given sample of water. iii. To determine the COD of the given wastewater sample.	15	3, 4
4	Total solids, total dissolved solids, and potassium content determination	i. To determine total solids (T.S.) and total dissolved solids (T.D.S.) in the given sample of water. ii. To determine the conductivity of the sample of water. iii. To find out the potassium in the given sample of water. iv. To find out matter in the air.	15	4, 5

Reference Books:

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.

Practical Organic Chemistry, A. I. Vogel.

Practical Physical Chemistry: B. Viswanathan and P.S. Raghavan.

Experimental Inorganic Chemistry –W. G. Palmer.

e-Learning Source:

https://www.fandm.edu/uploads/files/79645701812579729-genchem-reference-for-web.pdf

http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-16-1-vogelqu-d.pdf

https://faculty.psau.edu.sa/filedownload/doc-6-pdf-f06110ef2e1e1ae119cbacf71dd17732-original.pdf

https://www.stem.org.uk/resources/collection/3959/practical-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	3	3	1	1	-	-	-	-	-	-	-	-	-	2	3	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	-	1	2	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-	-	3	1	-	-
CO5	3	3	1	2	-	-	-	-	-	-	-	-	-	2	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: 2023-24							
Course Code	B000401V/CH244	**Title of the Course**	Organic Farming	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	1		2	3
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	This paper aims to impart knowledge about different organic farming approaches and organic farming's importance. After completing this program, participants will be able to: produce organic crops; grow and manage organic crops; maintain the quality of organic produce; and become knowledgeable about environmental health and safety.						

Course Outcomes	
CO1	Students understand organic farming, development of organic farming, concept of organic farming, organic concept, holistic concept, living soil concept, healthy plant concept.
CO2	Students know concepts and principles of organic farming, including the principles of health, ecology, fairness, and care.
CO3	Students know constraints for organic farming, potential customers for organic products in the domestic market, key indicators for organic farming, sustainable agriculture, and climate change.
CO4	Students understand input management, compost production, vermicomposting, compost quality, compost utilization, and marketing.
CO5	Students understand quality analysis of organic skill foods antioxidants and their natural sources, organic food, and human health standards for organic food and marketing.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	The science of modern farming	Definition of Students understand organic farming, development of organic farming, concept of organic farming, organic concept, holistic concept, living soil concept, healthy plant concept.	10	1
2	Introduction and principles	Introduction to organic farming and its significance; concepts and principles of organic farming, including the principles of health, ecology, fairness, and care.	10	2
3	Major organic products from India and key indicators	Constraints for organic farming, potential customers for organic products in the domestic market, key indicators for organic farming, sustainable agriculture, and climate change.	10	3
4	Management and marketing	Input management, compost production, vermicomposting, compost quality, compost utilization, and marketing.	10	4, 5
5	Organic crop management	Organic crop management: field skill crops, horticulture, and plantation crops; plant protection measures; biopesticides; natural predators; cultural practice.	10	4, 5
6	Quality analysis	Quality analysis of organic skill foods antioxidants and their natural sources, organic food, and human health standards for organic food and marketing.	10	5

Reference Books:

Alvarcs, C.,1996. The Organic Farming Source Book. The other India Press, Mapusa, Goa.

Gupta, M.,2004. Organic Agriculture Development in India. ABD publishers, Jaipur, India.

e-Learning Source:

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https://www.bing.com/videos/riverview/relatedvideo?&q=organic+farming&&mid=

	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	2	1	-	-	-	-	-	-	-	-	2	1	1	1	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	1	1	2	1	1
CO3	2	1	1	2	-	-	-	-	-	-	-	-	2	1	1	2	1
CO4	2	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1	2
CO5	1	2	1	1	-	-	-	-	-	-	-	-	2	1	1	2	1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	Z040401T	**Title of the Course**	Physical Education and Yoga	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Fourth	2			2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Equip students with a comprehensive understanding of physical education, fitness, and wellness. Gain knowledge in physical education, fitness, wellness, weight management, and lifestyle choices. Explore the relationship between yoga and mental health. Emphasize the value of education. Delve into traditional games, their cultural significance, and their benefits. Apply knowledge for physical fitness, mental well-being, and a balanced lifestyle. Develop critical thinking, problem-solving skills, communication skills, and appreciation for traditional games as part of cultural heritage and physical activity promotion.						

Course Outcomes	
CO1	Students understand the fundamental concepts and principles of physical education and can explain the concept of fitness and wellness and its significance in maintaining a healthy lifestyle.
CO2	Students can demonstrate knowledge of weight management techniques and strategies for maintaining optimal body weight as well as identify and analyze various aspects of an individual's lifestyle and its impact on overall health and well-being.
CO3	Students can recognize the relationship between yoga and mental health and understand how yoga practices contribute to mental well-being. Comprehend the importance of value education and its role in personal and social development.
CO4	Students can evaluate the traditional games of India and their cultural significance, highlighting their physical and mental benefits. Apply theoretical knowledge and practical skills acquired during the course to promote physical fitness, mental well-being, and a balanced lifestyle. Develop critical thinking and problem-solving abilities related to physical education and wellness.
CO5	Students can communicate effectively about the importance of physical education, fitness, wellness, and traditional games, both orally and in written form. Foster an appreciation for Indian traditional games and their role in preserving cultural heritage and promoting physical activity. Engage in teamwork, cooperation, and leadership skills through practical activities and group projects related to physical education and wellness.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Physical Education	i. Meaning, Definition, Aim and Objective. ii. Misconception About Physical Education. iii. Need, Importance and Scope of Physical Education in Modern Society. iv. Physical Education Relationship with General Education. v. Physical Education in India before Independence. vi. Physical Education in India after Independence.	15	1
2	Concept of Fitness and Wellness, Weight Management, and Lifestyle	i. Meaning, Definition and Importance of Fitness and Wellness. ii. Components of Fitness. iii. Factor Affecting Fitness and Wellness. i. Meaning and Definition of Obesity. ii. Causes of Obesity. iii. Management of Obesity. iv. Health problems due to Obesity. i. Meaning, Definition, Importance of Lifestyle. ii. Factor affecting Lifestyle. iii. Role of Physical activity in the maintains of Healthy Lifestyle.	15	2, 3
3	Yoga and Meditation	i. Historical aspect of yoga. ii. Definition, types of scopes & importance of yoga. iii. Yoga is related to mental health and value education. iv. Yoga is related to Physical Education and sports. v. Definition of Asana, differences between asana and physical exercise. vi. Definition and classification of pranayama. vii. Difference between pranayama and deep breathing. viii. Practical: Asana, Suraya-Namaskar, Bhujang Asana, Naukasana, Halasana, ix. Vajrasan, Padmasana, Shavasana, Makrasana, Dhanurasana, Tad Asana. x. Pranayam: Anulom, Vilom.	15	3, 4
4	Traditional Games of India and Recreation in Physical Education	i. Meaning. ii. Types of Traditional GamesGilli- Danda, Kanche, Stapu, Gutte, etc. iii. Importance/ Benefits of Traditional Games. iv. How to Design Traditional Games. i. Meaning, Definition of Recreation. ii. Scope and Importance of Recreation. iii. General Principles of Recreation. iv. Types of Recreational Activities. v. Aerobics and Zumba (Fir India Movement).	15	4, 5

Reference Books:

Singh, Ajmer, Physical Education and Olympic Abhiyan, “Kalayani Publishers”, New Delhi, Revised Addition, 2006; Patel, Shri krishna, Physical Education, “Agrawal Publishers”, Agra, 2014-15

Panday, Preeti, Sharirik Shiksha Sankalan, “Khel Sanskriti Prakashan, Kanpur

Kamlesh M.L., “Physical Education, Facts and foundations”, Faridabad P.B. Publications; B.K.S. Yengar, "Light and Yog. Yoga Deepika", George Allen of Unwin Ltd., London,1981.

BrajBilari Nigam, Yoga Power "TheKpath of Personal achievement" Domen and Publishers, New Delhi, 2001.

Indira Devi, "Yoga for You", Gibbs, Smith Publishers, Salt Lake City, 2002 Domenand Publishers, New Delhi - 2001.

Jack Peter, "Yoga Master the Yogic Powers", Abhishek Publications, Chandigarh, 2004.

Janice Jerusalim, "A Guide To Yoga" Parragon Bath, Baiihe-2004.

नारंग, **प्रियंका**, **परम्परागत भारतीय खेल**, " **स्पोर्ट्स पब्ललके शन"** , **नई दिल्ली**, 2007.

e-Learning Source:

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https://www.bing.com/videos/search?q=yoga&&view=detail&mid=C44E1F48814EBF788F1DC44E1F48814EBF788F1D&&FORM=VRDGAR&ru=%2Fvideos%2Fsearch%3Fq%3Dyoga%26FORM%3DHDRSC4

https://www.youtube.com/watch?v=s2NQhpFGIOg

https://www.youtube.com/watch?v=3p4r_ad2Y7g

https://www.youtube.com/watch?v=JYg0Vu6-RUk

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190301T/CH231	**Title of the Course**	Process Instrumentation and Industrial Chemical Analysis	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	3	1	0	4
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	On successful completion of students will gain the knowledge of important topics of industrial chemistry such as chromatography, thermal instrumentations, pressure measuring devices, liquid level measuring instruments, Industrial analysis, Modern instrumental analysis, spectroscopic methods, Effluent treatment, and wastewater management.						

Course Outcomes	
CO1	Students learn fundamental and how to apply chromatography techniques and their principles.
CO2	Students able to explore a range of temperature measuring instruments (glass thermometers, bimetallic thermometers, pressure spring thermometers, vapor field thermometers, resistance thermometers, and radiation pyrometers) and pressure measuring instruments (manometers, barometers, bourdon pressure gauges, diaphragm type pressure gauges, Macleod gauges, and Pirani gauges).
CO3	Students gain knowledge in level measurement techniques, viscosity, surface tension, density measurements, sampling procedures for solids, liquids, and gases, data processing, particle size determination, rheological properties of liquids, and plastics analysis.
CO4	Students know the fundamentals of pH and conductivity measurements with special reference to water and soil analysis, optical rotation of chiral compounds, and spectrophotometers. Furthermore, Bio-transformations: enzyme-catalyzed reactions, microwave-induced reactions principle, conditions, and advantages.
CO5	Students can explore principles and equipment for aerobic and anaerobic treatment, including anaerobic high-rate treatment, UASB reactors, EGSB reactors, EGSB/IC reactors, industrial treatment examples, as well as adsorption, filtration, sedimentation, bag filters, electrostatic precipitators, and sewage treatment plants (STPs).

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Chromatography	Principles, methods, and applications of various chromatographic techniques such as Paper, TLC, GLC, HPLC, GLC, and GPC.	7	1
2	Temperature measuring instruments	Glass thermometers, bimetallic thermometers, pressure spring thermometers, vapor field thermometers, resistance thermometers, and radiation pyrometers.	7	2
3	Pressure measuring instruments:	Pressure gauges, manometers, barometers, pirani gauges, macleod gauges, and diaphragm type pressure gauges.	7	2
4	Liquid level measuring instruments	Direct-indirect level measurements, float type liquid level gauges, ultrasonic level gauges; bubbler systems, viscosity (Ostwald viscometer), surface tension (stalagmometer), and density (pycnometer) measurements.	7	3
5	Industrial analysis	Sampling procedures, sampling of bulk materials, techniques of sampling solids, liquids, and gases, collecting and processing of data, particle size determination, rheological properties of liquids and plastics, and their analysis.	8	3
6	Modern instrumental methods of analysis	pH and conductivity measurements with special reference to water and soil analysis, optical rotation of chiral compounds, and spectrophotometer.	8	4
7	Techniques in Organic Synthesis	*Bio-tranformatons:* enzyme-catalyzed reactions, microwave-induced reactions Principle, conditions, and advantages over conventional heating methods Applications, sonication	8	4
8	Effluent treatment, wastewater management	Principles and equipment for aerobic and anaerobic treatment, like i) anaerobic high-rate treatment of industrial wastewater and its reuse in industries ii) UASB reactors iii) EGSB reactors iv) EGSB/IC reactors v) industrial treatment examples Adsorption, filtration, sedimentation, bag filters, electrostatic precipitators, and sewage treatment plants (STPs).	8	5

Reference Books:

Metcalf and Eddy, Wastewater Engineering Publisher - McGraw-Hill (2013).

H.S. Peavy, D.R. Rowe and G. Tchobanoglous; Environmental Engineering Publisher - McGraw-Hill (2015).

M. M. Benjamin, D. F. Lawler, Water Quality Engineering: Physical / Chemical Treatment Processes by La - John Wiley & Sons (2013).

V. Ranade V. Bhandari Industrial Wastewater Treatment, Recycling and Reuse, Elsevier (2014)

Reynolds P. Richard, Unit Operations and Processes in Environmental Engineering) by T.D. Publisher-CL Engineering (1996).

Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher (2009).

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).

Pavia, D. L. et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed.

Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California USA (1988).

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

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-Clapeyron 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	Student 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 $[Ti(H_2O)_6]^{3+}$ complex ion. Study magnetic properties, types of behavior, methods for determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μs 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-Clapeyron 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. *Gaseous State:* Postulates of the kinetic theory of gases: deviation from ideal behaviour, van der Waals equation of state. ii. *Critical phenomena:* 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. *Molecular Velocities:* Qualitative discussions of Maxwell's distribution of molecular velocities, collision number, mean free path, and collision diameter.	7	3
5	Liquid State	i. *Liquid State:* Intermolecular forces and the structure of liquids (a qualitative description) Structural differences between solids, liquids, and gases. ii. *Liquid crystals:* 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 valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral, and square planner complexes, the John Teller effect, and factors affecting the crystal-field parameters. ii. *Thermodynamic and kinetic aspects of metal complexes:* 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 $[Ti(H_2O)_6]^{3+}$ 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
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Shriver,D.E Atkins,P.W and Langford, C .H, Inorganic Chemistry ,Oxford University Press, 1994.
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Sharpe,A .G, Inorganic Chemistry, ELBS,3RD edition ,1993; Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
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R Gopalan& V Ramalingam, Concise Coordination Chemistry, Vishal publishing house; Tn Srivastva and Pc Kampoj, Systematic Nalytical Chemistry, Shoban Lal Nagin Chand
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	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 Correlation1

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190302P/CH233	**Title of the Course**	Industrial Chemical and Instrumentation Analysis	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	-	-	4	2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students learn instrumental methods of analysis, material testing, water analysis, use of transducers for flow control, and flow measuring devices-floats are discussed.						

Course Outcomes	
CO1	Students can use a colorimeter, flame photometer, pH meter, potentiometer, and conducto-meter.
CO2	Students are able to perform testing of plastics and rubber, young's modulus, optical, thermal, mechanical, and electrical properties.
CO3	Students can estimate barium as barium sulphate, sulphate as $BaSO_4$, silver as AgCl, chloride as silver chloride, zinc as zinc oxide, and copper as cupric oxide.
CO4	Students can estimate iron as ferric oxide, aluminum as Al_2O_3, chromium as chromic oxide, Cr_2O_3, and lead as lead sulphate.
CO5	Students are able to analyze common raw materials as per industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Instrumental methods of analysis	Use of a colorimeter, flame photometer, pH meter, potentiometer, and conducto-meter	10	1
2	Material testing	Testing of plastics and rubber, young's modulus, optical, thermal, mechanical, and electrical properties.	10	2
3	Gravimetric analysis	Students can estimate barium as barium sulphate, sulphate as $BaSO_4$, silver as AgCl, chloride as silver chloride, zinc as zinc oxide, copper as cupric oxide, iron as ferric oxide, aluminum as Al_2O_3, chromium as chromic oxide, Cr_2O_3, and lead as lead sulphate.	30	3, 4
4	Industrial analysis	Analysis of common raw materials as per the industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	10	5

Reference Books:

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

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C. W. Garland,.Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

A. M. Halpern, & M cBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman& Co.: New York (2003)

e-Learning Source:

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

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 dialometric 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 dialometric method (e.g. $MnCl_2.4H_2O$ or $SrBr_2.2H_2O$)	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).

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	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**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190303T/CH235	**Title of the Course**	Chemical Process and Unit Operation in Industry	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	3	1	-	4
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students are able to utilize knowledge of cement chemistry and characteristics to address construction and manufacturing issues. Identify various cement types and properties, including compressive strength, durability, and curing time. Describe the chemical reactions associated with cement production and the function of additives in enhancing its qualities. Comprehend the idea of setting duration and the variables that impact it, such as temperature, humidity, and water-cement proportion.						

Course Outcomes	
CO1	Aim to provide students with knowledge on the dangerous effects of some commercial methods and suggest alternative solutions, as well as analyzing the feasibility of different commercial preparations of essential organic substances.
CO2	Students able to analyze the advantages and disadvantages of batch and continuous organic preparations in the context of manufacturing, determining the application and mechanism of common organic reactions in commercial chemicals' manufacture.
CO3	An interest in organic synthesis in context with industrial chemistry is created among students.
CO4	Students will develop an understanding of the design and application of an analysis related to a question of relevance based on their experience in separation techniques.
CO5	Students will gain an understanding of the connection between common approximation methods and standard chemical adsorption and absorption.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Synthetic Nitrogen Products	Ammonia, nitric acid, ammonium nitrate and ammonium sulphate their manufacture with reference to; consumption Pattern, Raw materials, Production process, Quality control, Hazards and safety and Effluent management.	8	1
2	Alkali Industrial Products	Caustic soda Chlorine. Phosphorus chemicals; Phosphorus, phosphoric acid, ammonium phosphate, superphosphate, triple superphosphate. Lime, gypsum, Silicon, calcium carbide.	8	1
3	Cement	Introduction, Composition, Types of cement, Portland cement; raw Materials, manufacture of Cement by wet & Dry process, Reaction in the Kiln, setting of cement, Testing & Uses of cement.	7	2
4	Carbon Nanotubes	Synthesis, Single walled carbon nanotubes, Structure and characterization, Mechanism of formation, chemically modified carbon nanotubes, Doping, Functionalizing nanotubes, and Applications of carbon nanotubes.	7	2
5	Distillation	Introduction, Bath and continuous distillation, Separation of azeotropes, Plates columns and packed columns Absorption: Introduction: Equipment's- packed columns spray Columns, bubble columns, packed bubble columns, mechanically agitated contractors.	8	3
6	Evaporation	Introduction, Equipment -short tube (standard) Evaporator forced circulation evaporators, falling film evaporators, climbing film (upward flow) evaporators, wiped (agitated) film evaporator.	7	4
7	Filtration	Filtration: Introduction, filter media and filter aids, equipment's, plate and frame filter press, nutch filter, rotary drum filter, sparkler filter, candle filter, bag filter, centrifuge Drying: Introduction, free moisture, bound moisture drying curve; equipment's, tray dryer, rotary dryer, flash dryer, fluid bed dryer, drum dryer, spray dryer.	7	4
8	Crystallization And Extraction	Introduction: solubility, super-saturation nucleation, crystal growth; Equipment- tank crystallizer, agitated crystallizer, evaporator, crystallizer, draft tube crystallizer. Introduction: selection of solvent; Equipment's- Spray column, packed column rotating disc column, mixer-settler. Mixing- Introduction; mixing of liquid-liquid solid- Solid, liquid-solid systems.	8	5

Reference Books:

Shreve R.N. Brink. J.A., Chemical Process Industries, International student edition, Pubs: McGraw Hill Book Co. New York, 1960

Groggins P.M., Unit Process in Organic Synthesis, 5th edition, international student edition, Pubs: McGraw-Hill Book Co., New York, 1998

Dryden's outlines of Chemical Technology edited and revised by GopalaRao M. and Marshall S, Pubs: East-West Press, New Delhi, 2004.

Industrial Chemistry B.K.Sharma, goel publishing house.

Chemical process industries N.R Nerrisshreve.

Chemical process principales: part 1 & II – O.A / Hougen, K.M Watson RA Ragatz (CBS)

Shrev's Chemical process Industries: 5th edition – George T. Austin, McGraw Hill.

Chemical Thermodynamics by R.P.Rastogi et al; Principles of physical chemistry by Puri Sharma and Pathan

Essentials of Physical Chemistry, Bahl&Tuli, S. Chand & Co. Ltd.; Principles of Physical Chemistry, Puri, Sharma &Pathania, Vishal Publishing Co.

Simplified course in Physical Chemistry, Madan&Tuli, S. Chand & Co. Ltd.; Atkin's Physical Chemistry, Atkin, Oxford Press.

e-Learning Source:

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https://www.chemicalprocessing.com/

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B190304P/CH236	**Title of the Course**	Chemical Preparation and Analysis	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third			4	2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Students will be able to work effectively and safely in a laboratory environment with practical, technical, and communication skills and concepts to solve qualitative and quantitative problems, as well as transferable skills like the ability to work in teams as well as independently.						

Course Outcomes	
CO1	Students able to determine the density or specific gravity of an unknown liquid and to determine the solubility product of calcium hydroxide through the common ion effect of sodium hydroxide or any other strong alkali.
CO2	Students able to analyze the water equivalent of calorimeter.
CO3	Students able to demine the strengths of a given hydrochloric acid and acetic acid solution were determined through conductometric titration using a standard solution of sodium hydroxide.
CO4	Students able to prepare Borax/boric acid and chrome alum, and the level of calcium in chalk are estimated through permanganatometry.
CO5	Student able to investigate the absorption of acid by activated charcoal and determine the pH of a HCl solution with a pH meter.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Experiments in Density, and Solubility	i. Determine the density or specific gravity of an unknown liquid. ii. Determined the solubility product of calcium hydroxide using common ion effect of sodium hydroxide or of any other strong alkali. iii. Determined the solubility of KNO3 above room temperature by gravimetric method.	20	1
2	Water Equivalent and Conducto-metric Titration	i. To determine the water equivalent of calorimeter. ii. Conductometric titration. a. Determined the strength of a given hydrochloric acid by using standard solution of sodium hydroxide. b. Determined the strength of a given acetic acid solution by using standard solution of sodium hydroxide.	20	2, 3
3	Borax/Boric Acid, Chrome Alum, and Calcium Estimation	i. Preparation of borax/ boric acid. ii. Preparation of chrome alum. iii. Estimation of Calcium in Chalk by permagnatometry.	10	4
4	Acid Absorption by Activated Charcoal and pH Determination	i. To study the absorption of acid and activated charcoal. ii. To determine the pH of given HCl solution by using pH meter.	10	5

Reference Books:

Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.

Practical Organic Chemistry, A. I. Vogel.

Practical Physical Chemistry: B. Viswanathan and P. S. Raghavan.

Experimental Inorganic Chemistry –W. G. Palmer

Practical Chemistry: For B.Sc. I, II And III Year by S. Chand's

e-Learning Source:

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http://pioneer.netserv.chula.ac.th/~sanongn1/processing.pdf

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B000301V/CH237	**Title of the Course**	Food Testing and Quality Control	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	1		2	3
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Student able to comprehend the significance and evolution of food basics, understand the functions of food, identify and analyze plant and animal sources of food, gain knowledge of food processing from diverse plant sources, gain insight into milk and its products, comprehend the different types of food and acquire sufficient knowledge about the food industry.						

Course Outcomes	
CO1	Students understand the fundaments of food chemistry, history, water structure, and relations among food components.
CO2	Students are able to know the foundations of carbohydrates: monosaccharide, oligosaccharides, and polysaccharides; starch and cellulose derivatives as food constituents; sugar and related products nutritional value; lipids: components, food lipids, and health; antioxidants.
CO3	Students know the basics of protein structure and functions, enzyme structure and functions, vitamin structure, types, and functions, minerals and nutritional aspects, vegetables and fruits, and the bioavailability of nutrients.
CO4	Students know the basics of food pigments, colours, preservatives, and adulteration.
CO5	Students understand and evaluate food quality, laws, and standards.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction and history	Food chemistry, history, water structure and relations in food components.	10	1
2	Carbohydrates and Lipids	Carbohydrates: monosaccharide, oligosaccharides and polysaccharides, starch and cellulose derivatives as food constituents, sugar and related products nutritional value, lipids: components, food lipids and health, antioxidants.	10	2
3	Structure and function of Proteins & Vitamins	Proteins structure and functions, enzymes structure and functions, vitamins structure, types and functions, minerals and nutritional aspects, vegetables and fruits, bioavailability of nutrients	10	3
4	Food pigments and colors	Food oxidants, food pigments, natural and synthetic food colours, flavoring agents, sweeteners, emulsifiers and stabilizers, spices and herbs	10	4
5	Food preservatives and Adulteration of food	Food preservatives, organic foods, advantages and disadvantages of organic food, food fortification. Food adulteration, types of adulteration: intentional adulteration, incidental adulteration.	10	4
6	Evaluation of food quality, laws & standards	Evaluation of food quality, sensory tests, types of tests, objective evaluation and instruments used for texture evaluation Food laws, food standardization and regulation agencies in India, national standards, international standards.	10	5

Reference Books:
Voet D and Voet JG. Principles of Biochemistry. John Wiley and sons New York.
Moat AG and Foster J. W. Microbial Physiology. John Wiley and Sons, New York.
Willey J, Sherwood L. and Woolverton C. Prescott's Microbiology, McGraw Hil
U. Satyanarayan. Biochemistry, Elsevier; Robinson Dairy Microbiology.
Jay JM Modern Food Microbiology. Van Nostraaand Reinhold Co., New York.
Andrew Proctor Alternatives to conventional food processing, RSC pub.
Frazer WC and Westhoff DC Food Microbiology. Mcgraw Hill, New York.; Srilakshmi B Food Science, New Age Publication
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	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																
PO-PSO CO	**PO1**	**PO21**	**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	1	-	-	-	-	-	-	-	-	2	-	-	2	2
CO3	3	3	2	1	-	-	-	-	-	-	-	-	2	-	-	3	2
CO4	2	3	2	2	-	-	-	-	-	-	-	-	3	-	-	1	3
CO5	2	3	2	2	-	-	-	-	-	-	-	-	1	-	-	1	1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	Z030301T/ES225	**Title of the Course**	Human Values and Environment studies	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	2			2
Pre-Requisite	-	**Co-requisite**	-				
Course Objectives	Upon finishing the course, students will be able to come up with ethical reasoning for decision-making, frame ethical issues, and operationalize ethical choices. The course integrates various facets of human values and the environment.						

Course Outcomes	
CO1	Students can build fundamental knowledge of the interplay of markets, human value, ethics, and law and understand various challenges faced by individuals to counter unethical issues.
CO2	Students look at core concepts for business ethics as well as core concepts for anti-corruption.
CO3	Students look at core concepts for a morally articulate solution evolver to management issues in general, issues of sustainable development for a better environment, and know how environmental degradation has taken place.
CO4	Students should be aware of negotiations and international efforts to save the environment. How to develop sustainably Efforts taken up by the UN in Sustainable Development.
CO5	Students also know the efforts taken by India in sustainable development and the various environmental laws.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Human Values, Present Practices and Principles of Ethics	i. *Introduction:* Values, Characteristics, Types, Developing Value Systems in Indian Organizations, Values in Business Management, Value-Based Organizations, and Trans-cultural Human Values in Management Swami Vivekananda's philosophy of character building, Gandhi's concept of the Seven Sins, and APJ Abdul Kalam's view on the role of parents and teachers. ii. *Human Values and Present Practices*: Issues: Corruption and Bribe, Privacy Policy in Web and social media, Cyber Threats, Online Shopping, etc. Remedies: UK Bribery Act, Introduction to Sustainable Policies and Practices in the Indian Economy. *iii. Principles of Ethics:* Secular and Spiritual Values in Management: Introduction, Secular and Spiritual Values, Features, and Levels of Value Implementation Features of spiritual values. *iv. Corporate Social Responsibility:* Nature, Levels, Phases, Phases and Models of CSR, Corporate Governance CSR and Modern Business Tycoons Ratan Tata, Azim Premji, and Bill Gates.	07	1, 2
2	Holistic Approach in Decision making, Discussion through Dilemmas and Case Studies	i. *Holistic Approach in Decision Making:* Decision Making, the Decision-Making Process, The Bhagavad Gita: Techniques in Management, Dharma, and Holistic Management. ii. *Discussion through Dilemmas:* Dilemmas in Marketing and Pharma Organizations, Moving from Public to Private Monopoly Context Dilemma of privatization, Dilemma on liberalization, Dilemma on social media and cyber security Dilemma on Organic Food, Dilemma on Standardization, Dilemma on Quality Standards. *iii. Case Studies*	08	2, 3
3	Ecosystem and Biodiversity	i. *Concept, structure, and functions of ecosystems:* producer, consumer, decomposer, food web, food chain, energy flow, ecological pyramids. ii. *Conservation of Biodiversity:* In-situ and Ex-situ Conservation of Biodiversity Role of individuals in pollution control Human Population and Environment Sustainable Development India and the UN Sustainable Development Goals Concept of circular economy and entrepreneurship.	07	4
4	Environmental Laws, Quality, and Management	Environmental Laws, International Advancements in Environmental Conservation, Role of the National Green Tribunal, Air Quality Index, Importance of Indian Traditional Knowledge on the Environment, Bioassessment of Environmental Quality, Environmental Management System, Environmental Impact Assessment, and Environmental Audit.	08	5

Reference Books:
A foundation course in Human Values and Professional Ethics by RR. Gaur, R. Sangal et.al.
JUSTICE: What's the Right Thing to Do? Michael J. Sandel.
Human Values by A. N. Tripathi New Age International.
Environmental Management by N.K. Uberoi.
e-Learning Source:
https://www.un.org/sustainabledevelopment/sustainable-development-goals/
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https://www.legislation.gov.uk/ukpga/2010/23/contents/
Daniel Kahneman, Thinking, Fast and Slow; Allen Lane Nov 2011 ISBN: 9780141918921

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2024-25							
Course Code	B190501T/CH331	**Title of the Course**	Industrial Chemicals	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The chemical industry comprises the companies that produce industrial chemicals. Central to the modern world economy, it converts raw materials into more than 70,000 different products. On successful completion of this course, students will gain knowledge and skills related to various industrial gases, petroleum refining processes, carbon-based chemicals and industrial catalysts, the pulp and paper industry, surfactants, soaps, detergents, and cosmetics, the cane sugar industry, the manufacture of heavy organic chemicals, heavy inorganic chemicals, and fine chemicals.						

Course Outcomes	
CO1	Students would be able to create key knowledge for the manufacturing of N_2, O_2, H_2, CO_2, and petroleum refining processes.
CO2	Students would be able to evaluate and analyze the physical and chemical properties of carbon-based chemicals, industrial catalysts, and adhesives.
CO3	Students would be able to analyze and understand the chemistry of surfactants, soaps, detergents, cosmetics, and cane sugar.
CO4	Students would be able to perceive the sound knowledge of methods for the formation and manufacture of heavy organic and inorganic chemicals.
CO5	Students will be able to gain knowledge of methods of formation, raw materials, production processes, quality control, hazards and safety, and effluent management.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Industrial gases	Manufacture, uses and economics of N_2, O_2, H_2, CO_2.	6	1,
2	Petroleum refining process	Introduction, distillation, octane number, additives, hydro treating, cracking, reforming, alkylation and polymerization, separation of natural gas (methane production).	8	1
3	Carbon based chemicals and industrial catalysts.	Manufacture, properties and uses of methanol, formaldehyde, acetic acid, chlorofluoro carbons and fluorocarbons. Industrial catalysts like raney nickel, other forms of nickel, palladium and supported palladium, copper chromate, vanadium and platinum-based catalyst, aluminiumalkoxides, titanium tetrachloride and titaniumdioxide.	8	2
4	Adhesive:	Introduction, Classification of adhesives, adhesives action, development of adhesive strength, chemical factors influencing adhesive action.	6	2
5	Surfactants, soaps, detergents, and cosmetics:	Introduction, cationic and anionic surfactants, straight chain detergent intermediates linear alcohol sulphates (AS), linear alcohol ethoxysulphates (AES) and linear alkyl benzene sulfonates (LAS), amphoterics and detergent builders Definition and characteristics of cream, hair dyes, toothpaste, talcum powder, sun tan lotion, perfumes and essentialoils.	8	3
6	Cane sugar industry:	Manufacture of white crystalline sugar, extraction of the juice, clarification (lime defection process, by sulphate ion and by carbonation), evaporation, crystallization and refining of sugar, uses of bagasse.	8	3
7	Manufacture of heavy organic and inorganic chemicals	**Manufacture of heavy organic and inorganic chemicals (with respect to raw material, production process, quality control, hazards and safety, effluent management):** ***Heavy organic chemicals:*** Fischer-tropsch synthesis, applications, and uses of zeolites as catalyst, propyl alcohol, 1,4- butanediol, vinyl chloride, pyridines, picolines, phthalic anhydrides, glycerol, sorbitol, chloroform, ethanolamine. ***Heavy inorganic chemicals:*** Ammonium phosphates, carbonblacks, manufacture of graphite and carbon, calciumcarbide, silicon carbide, sodium thiosulphate, borax and boric acid.	8	4
8	Manufacture of fine chemicals	**Manufacture of fine chemicals (with respect to Raw material, Production process, Quality control, Hazards and safety, Effluent management):** Sodium borohydrate, lithium aluminium hydride, sodium ethoxide, paracetamol, indigo, vat dyes. Essential oils, surfactants and emulsifying agents, coloring agents-manufacture of some natural and synthetic colors. Flavouring agents-fragrance and food additives. Biochemical reagents-ninhydrin, tetrazolium blue, 1,2-naphthaquinone-4-sulphonate.	8	5

Reference Books:

1. B. K. Sharma, Industrial Chemistry, GOEL Publishing House (2000).
2. M. Fahim, T. Al-Sahhaf, A. Elkilani, Fundamentals of Petroleum Refining, 1st edition, Elsevier Science (2010).
3. Pesticide Calcer Publication, P. B.Pandey.
4. Principle Industrial Chemistry, C. A. Clausion, G. C.Mattson, Wiley(1978).
5. W. L. Mc. Cabe, J. C. Smith &Parriet , Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore(2017).
6. A. F. Mills. Heat Transfer, CRC Press, (1992).
7. K.W. Britt, Handbook of pulp and paper technology Book on Pulp & Paper Industries, 2Ed(2004).

e-Learning Source:

1. https://nptel.ac.in/courses/103/107/103107082/
2. https://nptel.ac.in/courses/103/103/103103029/
3. https://nptel.ac.in/courses/103/106/103106108/
4. https://nptel.ac.in/courses/104/105/104105103/

	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	-	-	2	1
CO2	2	1	-	-	-	2	-	2	-	-	1	2
CO3	1	1	-	-	-	1	-	3	-	-	3	1
CO4	3	3	-	-	-	2	-	2	-	-	1	1
CO5	2	1	-	-	-	12	-	2	-	-	3	2

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDGs -9

Effective from Session: 2024-25							
Course Code	B190502T/CH332	**Title of the Course**	Pollution its Management, and Industrial Economics	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	Students gain knowledge and skills related to this paper as follows: Pollutants, their statutory limits, air pollution, water pollution, pesticide pollution, solid and gaseous wastes, factors involved in project cost estimation, capital formation, methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, entrepreneurship, choice of technology, and quality control.						

Course Outcomes	
CO1	Students would be able to remember and apply the various principles of environmental pollutants, their statutory limits, and air pollution.
CO2	Students would be able to evaluate and analyze the environmental pollution and pesticide pollution.
CO3	Students would be able to understand and evaluate the physical and chemical properties, factors involved in project cost estimation, methods employed for the estimation of capital investment, and capital formation.
CO4	Students would perceive the sound knowledge of methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, the economics of selecting alternatives,
CO5	Students will be able to gain knowledge of plant, equipment and quality control.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Pollutants, their statutory limits and air pollution	Pollutants, their statutory limits and air pollution: Definition and classification of pollutants, primary and secondary pollutants, pollution evaluation methods, sources and classification of air pollution, major air pollutants and their health impacts, phenomenon of acid rain, photo chemical smog and ozonedepletion,composition of fly-ash, pollution control equipment/techniques.	6	1
2	Environmental pollution	Environmental pollution: Sources, causes and effects of 1.Soil pollution 2.Water pollution 3.Air pollution 4.Noise pollution	8	1
3	Basics of Environmental pollution	Basics of Environmental pollution: Meanings of some important terminologies 1.Global warming 2.Acid rain 3.Algal blooms 4.Carbon footprint 5.Greenhouse effect 6.Hazardous waste 7.Incineration 8.Landfill 9.Oil spill 10.Ozone depletion 11.Particulate matter 12.Radiation	8	2
4	Pesticide pollution	*Pesticide pollution* Classification of chemical pesticides, examples of organo-chlorines and organophosphates, persistent organic pollutants (POPs) and their half-lives, environmental effects of pesticides, soil and water contamination and its impact, bioaccumulation of pesticides and pesticide contamination in food.	6	3
5	Soil economics A	Factors involved in project cost estimation, methods employed for the estimation of capital investment, capital formation, elements of cost accounting, interest and investment costs, and time value of money equivalence.	8	3
6	Soil economics B	Methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, economics of selecting alternatives, variation of cost with capacity, break-even point, optimum batch sizes, production scheduling etc.	8	3,4
7	Soil economics C	Need, scope and characteristics of entrepreneurship, special schemes for technical entrepreneurs' development (STED), exposure to demand based, resource based, service based, import substitute and export promotion industries, criteria for principles of products selection and developments.	8	4
8	Choice of technology and quality control	Plant and equipment, techno-economic feasibility of the projects, plant layout and process planning for the project. Quality control, quality assurance and testing of the product, packaging, advertising and after sales service.	8	5

Reference Books:

1.R.K. Trivedy, N.S. Raman, Industrial Pollution and Environmental Management, Scientific Publishers Journals(2002).
2.M. Brusseau, I. Pepper, C. Gerba, Environmental and Pollution Science, Third Edition, Elsevier Science(2019).
3.H. S. Rathore, L.L.L. Nollet, Pesticides: Evaluation of Environmental Pollution, CRC Press(2012).
4.B. K. Sharma, Industrial Chemistry (including Chemical Engineering), GOEL Publishing House(2000).
5.P. F. Rad, Project Estimating & Cost Management, BerrettKochler Publisher(2001).

e-Learning Source:

1.https://nptel.ac.in/courses/105/103/105103205/
2.https://nptel.ac.in/courses/126/105/126105016/
3.https://nptel.ac.in/courses/126/105/126105010/

4.https://nptel.ac.in/courses/105/102/105102089/
5.https://nptel.ac.in/courses/122/106/122106030/
6.https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.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	1	2	-	-	-	1	-	2	-	-	2	1
CO2	2	1	-	-	-	2	-	2	-	-	1	2
CO3	1	1	-	-	-	1	-	3	-	-	3	1
CO4	3	3	-	-	-	2	-	2	-	-	1	1
CO5	2	1	-	-	-	12	-	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	B190503P /CH333	**Title of the Course**	Industrial chemicals and pollution management	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	0	0	8	4
Pre-Requisite	10+2	**Co-requisite**	-				
Course Objectives	The course objective is to provide knowledge and skills encompassing the determination of flash and fire points, the analysis of (i) the acid value for gum and resin, (ii) the iodine number for linseed oil and castor oil, and (iii) the saponification value for coconut oil, as well as the synthesis of organic compounds including paracetamol, aspirin, oils of wintergreen, and urea formaldehyde resin, and the analysis of common raw materials according to industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, and acetone, involving both gravimetric and volumetric estimations.						

Course Outcomes	
CO1	Students would be able to determine and evaluate flash and fire points, as well as acid value, gum, and resin.
CO2	Students would be able to understand and analyze iodine numbers (linseed oil), castor oil, saponification values (coconut oil).
CO3	Students would be able to perform and analyze the synthesis of organic compounds: paracetamol, aspirin, oils of winter green, and urea formaldehyde resin.
CO4	Students would be able to understand the synthesis of various organic compounds.
CO5	Students would be able to analyze common raw materials as per industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, gravimetric, and volumetric estimations.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Qualitative and quantitative analysis	Determination of flash and fire point Determination of (i) acid value- gum and resin (ii) iodine number- linseed oil, castor oil (iii) saponification value - coconut oil.	15	1,2
2	Synthesis of organic compound	Each step reaction monitors by TLC. Paracetamol, Aspirin, oils of winter green and urea formaldehyde resin.	15	3
3	Industrial analysis	Analysis of common raw materials as per the industrial specifications such asphenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc.	15	3,4
4	Gravimetric and volumetric estimations	Gravimetric and volumetric estimations.	15	3

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. 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.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris, D.C.Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
6.

e-Learning Source:

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. 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	3	2	1	-	1	-	-	-	2	3	-	-
CO2	2	2	1	-	2	-	-	-	1	2	-	-
CO3	2	3	1	-	1	-	-	-	3	2	-	-
CO4	3	2	1	-	1	-	-	-	2	3	-	-
CO5	2	3	1	-	1	-	2	-	1	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**

SDG 4

Effective from Session: 2024-25							
Course Code	B190505T/CH334	**Title of the Course**	Industrial Aspects of Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The main goal of this course is to provide knowledge of the various properties and roles of organometallic reagents in the synthesis of organic compounds such as Grignard reagents, organo-lithium, zinc, copper, palladium, nickel compounds, lithium aluminium hydride, sodium borohydride, alkoxides, boron aluminium hydride, organosilicon, gano-palladium, and lithium organo-cuprates compounds. Also introduce carbon nanotubes: synthesis, structure, characterization, mechanism, modification, and applications.						

Course Outcomes	
CO1	Students would be able to remember and evaluate the fundamentals of arenes, aromatic reagents, alkyl, and aryl halides.
CO2	Students will be able to think about and use the physical and chemical properties of monohydric and dihydric alcohols, including how they are named, how they are made, and how they react with aldehydes, ketones, carboxylic acids, and esters.
CO3	Students would be able to understand the chemical reactions of aldehydes and ketones.
CO4	Students would perceive the sound knowledge of methods and techniques in organic synthesis and organometallic reagents.
CO5	Students will be able to develop, create, and evaluate organic synthesis.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Arenes and Aromatics	Nomenclature of benzene derivatives. Kekule structure of benzene, Stability and carbon-carbon bond lengths of benzene, resonance, Huckel rule of aromaticity, Aromatic electrophilic substitution general pattern of the mechanism, Mechanism of nitration, halogenation. Sulphonation and Friedel-Crafts reaction.	6	1,
2	Alkyl and Aryl Halides	Nomenclature, classification, methods of formation and chemical reactions of alkyl halides. Mechanims of nucleophilic substitution reaction of alkyl halides (SN1 and SN2 reactions) with energy profile diagrams.	8	1
3	Alcohols	Monohydric alcohols- nomenclature, methods of formation, 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 and pinacol-pinacolone rearrangement. Trihydric alcohols –nomenclature, methods of formation and chemical reactions of glycerol.	8	2
4	Aldehydes and Ketones	Synthesis of aliphatic aldehydes and ketones with particular reference to acid chlorides, alcohols, carboxylic acids, Grignard reagent, alkenes and 1,3-dithianes. Synthesis of aromatic aldehydes by oxidation of alkyl benzene, Reimer-Tiemann reaction, gattermann-koch reaction and aromatic ketones by Friedal craft acylation.	6	2
5	Chemical Reaction of Aldehydes and Ketones	Mechanism of nucleophilic additions to carbonyl group with particular reference: aldol condensation, Cannizzaro reaction. Perkin reaction, Wittig reaction, Mannich reaction. Baeyer-Villiger oxidation, Meerwine Pondor of Verlay reduction, Clemmensen reduction and Wolff-Kishner reduction.	8	3
6	Techniques in Organic Synthesis	Bio-tranformatons – Enzyme catalysed reactions, Microwave induced reactions- Principle, conditions, advantages over conventional heating methods- Applications, sonication.	8	4
7	Organometallic Reagents	Synthesis and applications of Grignard reagents-organolithium, Zinc, Copper, Palladium, Nickel compounds in organic synthesis- Homogeneous catalytic reactions hydrogenation, hydroformylation.	8	4
8	Methods in Organic Synthesis	Organosilicon Compounds: Preparation and applications in organic synthesis; Applications of Pd (0) and Pd (II) complexes in organic synthesis- Suzuki and Sonogashira coupling, Heck reaction, Preparation and applications of lithium organocuparates. Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bismethoxy ethoxy aluminium hydride, boron aluminium hydride and derivatives-catalytic metal hydrogenation-dissolving metal reductions, Non-metallic reducing agents including enzymatic and microbial reductions.	8	5

Reference Books:

1. Advanced Organic Chemistry, Bahl&Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I& II, I.L. Finar
3. Fundamentals of Organic Chemistry, NafisHaider, S. Chand & Co. Ltd.
4. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, PragatiPrakashan

e-Learning Source:

1.https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Smith)/Chapter_06%3A_Understanding_Organic_Reactions
2.https://www.dummies.com/education/science/biology/the-basics-of-organic-chemistry/
3.https://www.toppr.com/guides/chemistry/organic-chemistry/

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

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2024-25							
Course Code	B190506T/CH335	**Title of the Course**	Food and Dairy Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Fifth	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The course objective is to provide knowledge of food constituents, food additives, and food processing techniques. The study of food laws and standards informs students about quality and safety assurance and food-related hazards. To introduce students to an understanding of the chemistry of milk constituents. Milk and various dairy products are discussed from the perspective of the chemical, physical, and biological changes that occur during processing.						

Course Outcomes	
CO1	Students would be able to understand Indian food law and food standards, the value of quality assurance, and safety assurance.
CO2	Students would be able to evaluate and develop the chemical structure and properties and argue the importance of food components, including carbohydrates, protein, lipids, vitamins, and minerals.
CO3	Students would be able to describe the principles of food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, as well as food packaging.
CO4	Students will be able to describe the composition of milk, identify the approximate content, integrate their knowledge of food chemistry, and describe the physicochemical characteristics of the main components.
CO5	The student will be able to explain how dairy products (such as fluid milk, yoghurt, butter, powder, and cheese) are made and the key functions of the processing steps involved. Furthermore, students will be able to explain and apply the processing techniques to produce milk products such as butter, cream, ghee, etc. and detect adulteration.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Governmental regulations	Introduction, Food laws and standards: Indian food safety laws and standards; Quality and safety assurance in food industry; BIS Laboratory Services and Certification by BIS.	6	1,
2	Constituents of food and their nutritive aspects	Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals.	8	1
3	Food processing techniques	Common unit operations, Food deterioration and their control; Heat preservation and processing, Cold preservation and processing Food dehydration, Food concentration & food packaging.	8	2
4	Food additives	Preservatives, Antioxidants, Chelating agents, Surface active agents, Stabilizing and Thickening agents, buffering agents, Coloring agents, Sweetening agents & Flavoring agents.	6	2
5	Food safety, risks and hazards	Food related Hazards, Microbiological Considerations in food safety, Effects of processing and storage on microbial safety, Chemical hazards associated with foods, Prevention methods from food born disease.	8	3
6	Properties of milk	Definition, Composition, Milk lipids, Milk proteins, vitamins, and minerals. Factors affecting the composition of milk, adulterants, preservatives. Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals.	8	4
7	Processing of milk	Effect of heat on milk, chemical changes taking place in milk due to processing, sterilization, homogenization and pasteurization, vacuum pasteurization, and ultra-high temperature pasteurization.	8	4
8	Milk products	Cream; definition, chemistry of creaming process. Butter: definition, composition, theory of churning, desi butter, salted butter. Ghee; major constituents, common adulterants and their detection. Fermentation of milk; definition and conditions. Ice cream. Composition, types, manufactures of ice - cream, stabilizers, emulsifiers, and their role. Milk powder, process of making milk powder.	8	5

Reference Books:

Food Chemistry, Belitz and Gosch, Springer – Verlag Bertin Heiderberg, 2nd Edition, 1999
Principles of Human Nutrition, Martin Eastwood, Chapman and Hall, London, I Edition, 1997.
Food – The Chemistry of its Components, T.P. Coultate, Royal Soc. Chemistry, 4th Edition, 2002.
Food additives, Branan, Alfred Larry, Davidson P. Michae, Food Science and Technology series (35), Morcel Dekker, Inc, 1990.
Applied Chemistry-K.Bagavathi Sundari MJP Publishers Chennai. 2006.
Principles of dairy technology - Robert Jenness
Indian Dairy Products - Rangappa and Acharya, K.T.
Fundamentals of Dairy chemistry - Wond. F.P. Springer

e-Learning Source:

http://www.basicknowledge101.com/pdf/Food%20chemistry.pdf
https://courses.foodcrumbles.com/courses/food-chemistry-basics/
https://www.cabdirect.org/cabdirect/abstract/19710406009
https://byjus.com/chemistry/food-chemistry/
https://www.youtube.com/watch?v=S4brYhScYlc
http://ouat.nic.in/sites/default/files/2-properties_of_milk_dairy_and_food_engineering.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	1	2	-	-	-	1	-	1	-	-	2	3
CO2	2	3	-	-	-	2	-	2	-	-	1	2
CO3	3	1	-	-	-	1	-	1	-	-	3	1
CO4	3	3	-	-	-	2	-	2	-	-	1	3
CO5	1	1	-	-	-	1	-	2	-	-	1	2

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2024-25							
Course Code	B190504R/CH336	**Title of the Course**	Industrial 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	B190601T/CH343	**Title of the Course**	Synthetic Polymer	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The main goal of this course is to give students a basic understanding of the science behind large molecules. This includes how to classify polymers, molecular weight principles, and polymer solutions. Students will delve into the synthesis, properties, and applications of diverse polymers, including thermosetting, thermoplastics, conducting, light-emitting, and biodegradable polymers. With a focus on career-oriented aspects, the course covers polymer synthesis, processing, testing, degradation, reactions, composites, and real-world applications, opening doors to diverse opportunities in the dynamic field of polymers.						

Course Outcomes	
CO1	Students will gain knowledge of the brief history, basic chemistry, and nomenclature of polymers.
CO2	Students will get insight into the types and general classification of polymers.
CO3	Students evaluate the fundamentals of molecular weight, molecular weight distribution, and polymer solutions.
CO4	Students would gain knowledge of the structure and morphology, synthesis, properties, and applications of the following thermosetting polymers: thermoplastic polymers and conducting polymers.
CO5	Students would get key insights from the study of polymer synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites, and applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	The science of large molecules	Brief history, general definitions, basic chemistry and nomenclature of polymers, brief history of macromolecular science, general characteristics of polymers.	8	1
2	Types & general classification of polymers:	Natural and synthetic polymers, organic & inorganic polymers, thermoplastics & thermosetting polymers, homo, hetero and copolymers, necessity of copolymers and copolymerization, block and graft copolymers, conducting polymers, biopolymers. Mechanism of Addition, condensation, free radical, ionic (anionic and cationic) and coordination polymerization.	8	2
3	Molecular weight and molecular weight distribution	Number, weight & viscosity average molecular weights of polymers, methods of determining molecular weights, significance of molecular weight distribution.	6	2
4	Polymer solutions, structure and morphology	Criteria of polymer solubility, solubility parameters, fractionation of polymers with special reference to gel permeation chromatography.	6	3
5	Polymer structure and morphology	A brief idea of microstructure of polymers based on chemical and geometrical structures, intermolecular forces and chemical bonding in polymers, linear, branched and cross linked polymers, stereoregular polymers, crystallinity in polymers, effect of crystallinity on the properties of the polymers, factors affecting the crystallinity.	8	3
6	Synthesis, properties and applications of the following Thermosetting polymers	Unsaturated polyesters: Fibre reinforced plastics (FRP), Polyurethanes, Phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, Polycarbonates, Alkyl resins and amino resins, Epoxy resins – grades and curing process and its importance with mechanism, Silicones. Elastomers – polyisoprene, polybutadiene and neoprene.	8	4
7	Synthesis, properties and applications of the following Thermoplastics polymers	Polyethylene – HDP, LDP, LLDP. Polyvinyl chloride, PTFE (Teflon). Polystyrene – SBR, ABS, SAN. Vinyl polymers – PVA, PVB. Polyacetals, Polyamides – nylon-6, nylon-66 Polyethers and Polyesters – terephthalates (PET). Cellulosic polymers. Acrylic Plastics-PMMA	8	4
8	Synthesis, properties and application of specific polymers	1.Conducting polymers: Polyacetylene (PAc), Polyaniline (PANI), Polythiophene (PTh) 2. Light emitting polymers: Polyparaphenylene (PPP), Polyparaphenylenevinylene (PPPV), Polyfluorene (PF). 3.Biodegradable polymers:Polyglycolic acid (PGA),Polyhydroxybutyrate (PHB), Polyhydroxybutyrate-co-valerate (PHBV)	8	5

Reference Books:

U. R. Gowariker, N.V. Vishwanathan and J. Shreedhar, Polymer Science by, New Age International Publishers, New Delhi (1987).

H. G. Elias, an introduction to polymer science, Wiley (1997

An Introduction to polymer science and Technology, N. B. Singh, S. S. Das, New age Internal Publisher, New Delhi (2017).

P. Chandrasekhar Conducting Polymers, Fundamentals and Applications, Springer (2013).

A. Lendlein, A. Sisson, Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications, Wiley-VCH (2011).

A. J. Domb, J. Kost, D.d Wiseman, Handbook of Biodegradable Polymers, CRC Press (2019).

Handbook of Thermoset Plastics, 4th Edition, Hanna Dodiuk, Elsevier (2021).

F.W. Billmeyer, Textbook of polymer Science, John Wiley &Sons, New York (1984).

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https://nptel.ac.in/courses/103/107/103107139/

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDG 4- Quality Education	
SDG 8- Decent Work and Economic Growth	

Effective from Session: 2024-2025							
Course Code	B190602T/CH344	**Title of the Course**	Polymerization Techniques and Characterization	**L**	**T**	**P**	**C**
Year	Three	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	This course mainly includes the study of polymer synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites, and applications. This course is career-oriented and can provide various opportunities in the field of polymers. After successful completion of this paper, students will gain knowledge and skills related to the following: rheology and mechanical properties of polymers, degradation of polymers, polymerization techniques, plastic technology, fibre technology, elastomer technology, additives, and compounding.						

Course Outcomes	
CO1	Students would be able to perceive the sound knowledge and understanding of the rheology and mechanical properties of polymers.
CO2	Students will develop a comprehensive knowledge of the degradation of polymers and polymerization techniques.
CO3	Students will develop a comprehensive knowledge of various plastic technologies.
CO4	Students will gain knowledge of various concepts of fibre and elastomer technology.
CO5	Students will gain comprehensive knowledge of various additives and compounding ingredients in polymers.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Rheology and mechanical properties of polymers	Viscous flow, rubber elasticity, visco elasticity, glassy state and the glass transition temperature, (GTT) factors affecting glass transition temperature, optical, electrical and thermal properties of polymers.	8	1
2	Degradation of polymers	Degradation of polymers by thermal, oxidative, mechanical and chemical methods, randomdegradation and chain depolymerization.	8	2
3	Polymerization techniques	A general idea of bulk, solution, suspension, emulsion, polymerization processes.	8	2
4	Plastic technology	General concept of plastics; A brief idea of compression molding, injection molding, extrusion and blow molding techniques, thermoforming and foaming, casting, extrusion, fiber spinning, coating and calendaring, vulcanization of elastomers, reinforcing (fiber reinforced plastics - FRP).	6	3
5	Fiber technology	General concept of fibers; A brief idea of textile and fabric properties, fiber spinning (wet, dryand melt spinning)	8	4
6	Elastomer technology	General concept of elastomers; Vulcanization of elastomers, and its chemistry.	8	4
7	Additives	A general idea of fillers, plasticizers, antioxidants, colourants, fire retardants, thermal stabilizers.	8	5
8	Compounding	A general idea compounding ingredient etc.	6	5

Reference Books:

Joel R. Fried, Polymer Science &Technology, Pearson Prentice Hall; 3rd edition (2014).

B. K. Sharma, Polymer Chemistry,. Krishna Prakashan Media (2020).

D. J. Williams, Polymer Science & Engineering, Prentice Hall Inc (1971).

J.A. Brydson. Plastics Material, A. Brydson, Vth Edition, Butter Worth Heinemonn (1989).

G. Odian, Principle of Polymerization, Godian IInd edition, John Wieley & Sons (2004).

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https://www.youtube.com/watch?v=GltrPpUJS9Q 4. https://nptel.ac.in/courses/112/107/112107221/

https://nptel.ac.in/courses/116/102/116102026/

https://www.digimat.in/nptel/courses/video/103103139/L20.html 2. https://nptel.ac.in/courses/113/105/113105028/

https://www.youtube.com/watch?v=GltrPpUJS9Q 4. https://nptel.ac.in/courses/112/107/112107221/

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	3	-	3	3	3
CO2	3	3	-	-	2	-	-	3	-	3	3	3
CO3	3	3	-	-	2	-	-	3	-	3	3	3
CO4	3	3	-	-	2	-	-	3	-	3	3	3
CO5	3	3	-	-	2	-	3	3	-	3	3	3

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDG-4,8

Effective from Session: 2024-25							
Course Code	B190603P/CH345	**Title of the Course**	Synthesis and Analysis of Polymers	**L**	**T**	**P**	**C**
Year	Second	**Semester**	Third	**0**	**0**	**4**	**2**
Pre-Requisite	Diploma	**Co-requisite**					
Course Objectives	On successful completion, students will gain knowledge and basic laboratory techniques for the synthesis and characterization of polymers, the determination of saponification values, material testing, and the determination of the molecular weight of polymers by various techniques.						

Course Outcomes	
CO1	Students would be able to remember and analyse the laboratory techniques for the synthesis and characterization of polymers.
CO2	Students would be able to develop and create representative polymers such as bulk polymerization like polystyrene, PMMA nylon, and polysulphide rubber, solution polymerization like phenol formaldehyde and urea formaldehyde.
CO3	Students would be able to understand and evaluate the (i) saponification value of polyester, (ii) viscosity of PMMA, and (iii) hydroxyl value of a resin.
CO4	Students would be able to perform and test plastics and rubber, Young's modulus, optical, thermal, mechanical, and electrical properties.
CO5	Students would be able to analyze and determine the molecular weights of the polymers based on viscosity measurements and the Tg value of phosphate glasses.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Preparation of representative polymers	Bulk polymerization: Polystyrene, PMMA, Nylon and polysulphide rubber Solution polymerization: Phenol formaldehyde, urea formaldehyde	15	1,2
2	Determination of saponification value and viscosity	Determination of (i) saponification value - polyester (ii) viscosity of PMMA (iii) hydroxyl value of a resin.	15	2,3
3	Material testing	Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties	15	2,4
4	Determination of molecular weights	Determination of molecular weights of the polymers by viscosity measurements and Tg value of phosphate glasses.	15	2,5

Reference Books:

Armarego, W.L.F. Chai, C.L.L. Purification of Laboratory Chemicals (Elsevier, Burlington, 2009)

J. B. Rabek, Experimental methods In Polymer Chemistry, Wiley–Blackwell (1980).

Sorensen, W.R. Campbell, T.W. Preparative Methods of Polymers Chemistry (Wiley, New York, 1968)

Davis, F.J. Polymer Chemistry: A Practical Approach (Oxford, London, 2004)

e-Learning Source:

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

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**

SDG 4

Effective from Session: 2024-25							
Course Code	B190604R/CH346	**Title of the Course**	Industrial Chemistry Research Project-1	**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)											
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	B190605T /CH347	**Title of the Course**	Pharmaceutical and Phytochemicals	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	After successful completion of this course, students will gain the knowledge and skills related to this paper, which are as follows: pharmaceutical industry and pharmacopoeias, various types of pharmaceutical excipients, evaluation of crude drugs, surgical dressing, sutures, ligatures, phytochemicals, chemical constitution of plants, various isolation procedures for active ingredients, pharmaceutical quality control, and packaging materials						

Course Outcomes	
CO1	Students would be able to perceive and analyze the sound knowledge of the pharmaceutical industry, pharmacopoeias, and various types of pharmaceutical excipients.
CO2	Students would be able to gain insight into the evaluation of crude drugs, surgical dressings, sutures, and ligatures.
CO3	Students would be able to evaluate the fundamentals of phytochemical plant classification and crude drugs, cultivation, collection, preparation for the market, and storage of medicinal plants.
CO4	Students would be able to perceive and remember sound knowledge of the chemical constitution of plants and various isolation procedures for active ingredients.
CO5	Students would be able to understand and analyse pharmaceutical quality control and packaging materials.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Pharmaceutical industry and Pharmacopoeias	Historical background and development of pharmaceutical industry in India in brief, development of Indian pharmacopoeia and introduction to B.P., U.S.P., E.P., N.F. and other important pharmacopoeias, introduction to various types of formulations and roots of administration, aseptic conditions, need for sterilization, various methods of sterilization.	6	1
2	Various types of pharmaceutical excipients	Chemistry, process of manufacture and quality specifications – Glidants, lubricants, diluents, preservatives, antioxidants, emulsifying agents, coating agents, binders, colouring agents, flavouring agents, gelatin and other additives, sorbitol, mannitol, viscosity builders etc.	6	1
3	Evaluation of crude drugs	Moisture contents, extractive value, volatile oil content, foreign organic matter, quantitative microscopic exercises including of starch, leaf content (palisade ratio, stomatal number, vein islet number and vein termination number) and crude fiber content, various isolation procedures for active ingredients.	10	2
4	Surgical dressing, sutures, ligatures	with respect to the process, equipments used for manufacture, methods of sterlization and quality control.	6	2
5	Phytochemicals	Introduction to plant classification and crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants.	8	3
6	Chemical constitution of plants	including carbohydrates, amino acids, proteins, fats, waxes, volatile oils, terpenoids, steriods, saponins, flavonoids, tannins, glycosides, alkaloids.	8	4
7	Various isolation procedures for active ingredients	With example for alkaloid, e.g., vincaalkaloids, reserpine; one for steriods-sapogenin, diosgenin, diagroh.	8	4
8	Pharmaceutical quality control and packaging materials	Sterility testing, pyrogenic testing, glass testing, bulk density of powders, etc. (other than the analytical methods covered under core subject), ancillary materials, packaging machinery, quality control of packaging materials.	8	5

Reference Books:

L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).

C. O. Wilson, O. Gisvold & R. F. Doerge, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).

W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).

D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021)

G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).

John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019)

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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	2	-	-	-	-	-	3	-	-	2	3
CO2	1	1	-	-	-	-	-	2	-	-	3	2
CO3	3	2	-	-	-	-	-	3	-	-	3	2
CO4	1	2	-	-	-	-	-	3	-	-	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	B190606T /CH348	**Title of the Course**	Medicinal Chemistry and Toxicology	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The main objective of this course is to provide pharmacy students with a thorough understanding of drug mechanisms of action, acid-base and physicochemical properties, and absorption, distribution, metabolism, excretion, and toxicity profiles. Students gain knowledge and skills related to this paper, as follows: Pharmacology drug classification, introduction to medicinal chemistry, drug metabolism, principles of toxicology, biotransformation processes, and enzymes.						

Course Outcomes	
CO1	Students would be able to understand and analyze the pharmacology, drug classification, and introduction to medicinal chemistry.
CO2	Students would be able to evaluate and remember the drug metabolism and principles of toxicology.
CO3	Students would be able to understand and evaluate the fundamentals of microbial fermentation, the general principles of fermentation processes and product processing, and a brief idea of microorganisms, their structure, growth, and usefulness.
CO4	Students would be able to remember and understand the process of manufacturing the following bulk drugs and biotransformation processes.
CO5	Students would be able to understand and analyze the enzyme systems that are useful for transformation, microbial products, enzyme-catalyzed transformation, and the manufacture of ephedrine.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Pharmacology and Drugs classification	Pharmacology classification and therapeutic classification with example, history of the CSA, DEA and FDA, drugs & cosmetics act, schedule of drugs 1 to 5, concept of drug master file (DMF), infringing and non-infringing process concept, introduction of patent and its filing process in brief.	8	1
2	Introduction to medicinal chemistry	History and development of medicinal chemistry, physicochemical properties in relation to biological action, ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism, optical and geometrical isomerism.	8	1
3	Drug metabolism	Drug metabolism principles- phase I and phase II, factors affecting drug metabolism including stereo chemical aspects.	6	2
4	Principles of Toxicology	Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning, heavy metals and heavy metal antagonists	6	2
5	Microbial fermentation	General principle of fermentation processes and product processing, brief idea of microorganisms, their structure, growth and usefulness, enzyme systems useful for transformation microbial products.	6	3
6	Process of manufacture of the following bulk drugs	(i) Sulpha drugs- Sulphaguadine, Sulphamethoxazole (ii) Antimicrobial- Chloraamphenicol, Furazolidine, Mercurochrome, Isoniazid, Na- PAS (iii) Antalgesic- anti-inflammatory- Salicylic acid and its derivatives, Ibuprofen, Mefenamic acid. (iv) Steroidal hormones- Progesterone, Testosterone, Methyl testosterone (v) Vitamins- Vitamin-A, Vitamin-B6, Vitamin-C. (vi) Barbiturates- Pentobarbital (vii) Blockers- Propranolol, Atenolol (viii) Cardiocascular agent- Methyl dopa (ix) Antihistamines- Chloropheneramine maleate. 16h 41 41 (x)Antibiotics drugs – Penicillin-G, semi synthetic penicillin, Rifamycin, Tetracycline, and Vitamin-B12. (xi)Antimalarial drugs. Anticancerous drugs. Anti AIDS vaccines	16	4
7	Biotransformation processes	For prednisolone, 11-hydroxylation in steroids, enzyme catalyzed transformation, manufacture of ephidrine.	5	4
8	Enzyme systems	Useful for transformation, microbial products, enzyme catalyzed transformation - manufacture of ephedrine.	5	5

Reference Books:

M.E. Wolff, Burgers Medicinal Chemistry and Drug Discovery Wiley–Blackwell; 5th edition (1997).

W. David, Pharmaceutical Chemistry, Elsevier-Health U.K. (2011).

C. Donald, Essential of Pharmaceutical Chemistry, Pharmaceutical press, London (2012).

L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).

C. O. Wilson, O. Gisvold & R. F. Doerge. Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).

W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).

D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021).

G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).

John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019).
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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	1	2	-	-	-	-	-	3	-	-	2	1
CO2	3	2	-	-	-	-	-	2	-	-	1	2
CO3	2	1	-	-	-	-	-	1	-	-	3	3
CO4	2	2	-	-	-	-	-	1	-	-	1	1
CO5	1	1	-	-	-	-	-	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	B190607P/CH349	**Title of the Course**	Experimental Pharmaceutical Chemistry	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	**0**	**0**	**4**	**2**
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	Students gain knowledge and skills related to this paper as follows: Demonstration of various pharmaceutical packaging materials, quality control tests of some materials (aluminium strips, cartons, glass bottles), active ingredient analysis of a few types of formulations representing different methods of nalysis (aacidmetry, alkametry, nonaqueous complexometry, potentiometry, etc.), evaluation of crude drugs, microbiological testing.						

Course Outcomes	
CO1	Students would be able to understand and analyse the laboratory methods and tests related to pharmaceutical packaging.
CO2	Students would be able to understand and perform the quality control tests of some materials, such as aluminium strips, cartons, and glass bottles.
CO3	Students would be able to remember and perform the active ingredient analysis using different methods of analysis: acidmetry, alkametry, nonaqueous complexometric, potentiometry, etc.
CO4	Students would be able to evaluate and perform microscopic examinations—the determination and identification of starch granules and calcium oxalate.
CO5	Students would be able to evaluate and perform microbiological testing and determine the MIC of some antibacterial and antifungal drugs.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Pharmaceutical packaging	Demonstration of various pharmaceutical packaging materials and quality control tests of some materials- aluminium strips, cartons, glass bottles.	10	1,2
2	Active ingredient analysis	Active ingredient analysis of few types of formulations representing different methods of analysis- acidmetry, alkametry, nonaqueous complexometry, potentiometry, etc.	10	3
3	Evaluation of crude drugs	Microscopic examination- determination and identification of starch granules, calcium oxalate.	20	2,4
4	Microbiological testing	Determination of MIC of some antibacterial and antifungal drugs by zone/cup plate methods.	20	2,5

Reference Books:

Dickson, Experiments in Pharmaceutical Chemistry, CRC Press (2014).

S. K. Dwivedi, Practical Lab Manual of Pharmaceutical Organic Chemistry – I, IP, innovative publication pvt ltd (2014).

C. Kokare Pharm. Biotechnology Experiments & Techniques - Pharmaceutical Biotechnology - Experiments and Techniques Fifth Edition, Nirali Prakashan (2019).

e-Learning Source:

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2024-25							
Course Code	B190609T/CH350	**Title of the Course**	General & Halogenated Insecticide	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	Agrochemicals are used to prevent the deterioration of crops from insects, pest infestations, and disease. The global agrochemicals market report offers the latest trends, growth factors, industry competitiveness, investment opportunities, and a detailed profile of the top players in the market during the forecast period. The global agrochemicals market is segmented by product type (fertilisers, pesticides, adjuvants, and plant growth regulators), application (crop-based and non-crop-based), and geography. Students gain knowledge related to pesticides: inorganic insecticides, insecticides of plant origin, organophosphorus insecticides, organothiophosphorus insecticides, carbamate insecticides, chemical and biological fertilisers, and chlorinated pesticides.						

Course Outcomes	
CO1	Students would be able to create and develop different types of pesticides and their effects on soil and the environment.
CO2	Students would be able to remember and analyse inorganic insecticides and insecticides of plant origin.
CO3	Students would be able to evaluate the fundamentals of phosphoric acid, dhiophosphoric acid, and dithiophosphoric acid derivatives of organophosphorus insecticides.
CO4	Students would be able to evaluate the modes of action and their applications in carbamate insecticides and chemical and biofertilizers for crop protection.
CO5	Students will be able to gain knowledge of SAR and the mode of action of chlorinated hydrocarbons.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Types of pest and pesticides	Stomach poison, contact poisons systemic poisons, fumigants. Effect of pesticides on soil and environment.	7	1
2	Inorganic insecticides	Arsenic insecticides, Paris green, Fluoro insecticides	5	2
3	Insecticides of plant origin	Nicotine, Nornicotine, Pyrethroids, Rotenoids, Anabasin, Aliethrin	6	2
4	Organophosphorus insecticides	Phosphoric acid derivatives- Dimecron, dichlorovos, naled, phosphinon, etc. SAR in the class	5	3
5	Organothiophosphorus insecticides:	Thiophosphoric acid derivatives- Parathion, Methyl parathion, Thiophos, Demetron, Chlorthion, Paraoxon, etc. Dithiophosphoric acid derivatives- Melathion, Dimethoate, Thiocron, Formathion, Mecarbam, etc.	10	3
6	Carbamate insecticides	Carbaryl, Isolan, Mesurol, Zactran, Demetram, Pyrolan, Baygon, mode of action	8	4
7	Chemical and Biofertilizers	Introduction, Types of fertilizer, direct application fertilizers, mixed fertilizers (nitrogen, phosphorus and potassium sources, ammoniation), controlled release fertilizers and biofertilizers, liquid vs solid fertilizers, biopesticides.	9	4
8	Chlorinated hydrocarbons	DDT, DDD, Nestran, Dilan, Perthan, Dimite, Chlorobenzilate, Sulphenex, Ovotran, Aramite, DFDT, SAR in the class and mode of action, BHC, Chlordane, Heptachlor, Aldrin, Dieldrin, endrin, Faodrin, Endosulfan, SAR in the class and mode of action.	10	5

Reference Books:

Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)

J. P. Kumar and S. Bharat " Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016)

H. Ohkawa, H. Miyagawa, P. W. Lee Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety, Wiley (2007).

R. Pohanish, Sittig's Handbook of Pesticides and Agricultural Chemicals, Elsevier Science (2014)

Insecticides and Pesticides: Techniques for Crop Protection, Larsen and Keller Education, Technology & Engineering -

e-Learning Source:

https://nptel.ac.in/courses/103/107/103107086/

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https://nptel.ac.in/courses/126/104/126104003/

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDGs 2, 8, 12

Effective from Session: 2024-25							
Course Code	B190610T/CH351	**Title of the Course**	Fungicides and Herbicides	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	3	1	0	4
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	Fungicides, herbicides, and insecticides are all pesticides used in plant protection. Herbicides are a broad class of pesticides that are used to remove nuisance plants, such as grasses and weeds, that may compromise the growth and yield of desired crops that are in proximity.						

Course Outcomes	
CO1	Students would be able to create and develop types of fungicides and organomercuric compounds.
CO2	Students would be able to understand dithiocarbamates and miscellaneous fungicides.
CO3	Students would be able to evaluate the fundamentals of herbicides and their applications in plant protection.
CO4	Students will be able to understand the synthesis and uses of fumigants, rodenticides, nematicides, and plant growth regulators.
CO5	Students would be able to learn about different types of formulations of pesticides.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Fungicides	Introduction, Sulphur, lime sulphur, copper sulphate, bordeaux mixture, bordeaux paste, bordeaux paint, burgundy mixture, copper oxychloride, cuprous oxide, mercurous chloride	8	1
2	Organomercuric compounds	Ethyl mercuric chloride, ceresan-M, panagen, agalol, uspulan, puratized, germisan; mode of action, agrosan GN.	8	1
3	Dithiocarbamates	Ziram, ferbam, thiram, nabam, zineb, maneb, captan, hinosan, vapam, etc.; mode of action.	6	2
4	Miscellaneous fungicides	Dithanon, diclone, captan, polpet, diflolatan, mesulfan, brestan, dodine, glyodin, methyrimol, terrazole	8	2
5	Herbicides	Introduciton, heterocyclic nitrogen herbicides: 2,4-D; 2,4-DB; 2,4-DES; MCPB; 2,4,5-I, Monujron, fenuron, TCA, paraquat.	6	3
6	Fumigants, Rodenticides and Nematicides	Fumigants: HCN, CS2, ethylene halides, durofume, methyl halides. Rodenticides: Zice phosphide, warfarin Nematicides: DD mixture, aldicarb, fensulfothion	8	4
7	Plant growth regulators	Introduction, gibberilic acids, indole acetic and butyric acids, naphthalene acetic acid, cycocil, mode of action	8	4
8	Formulation of pesticides	Dry formulations- Dusts, grannules, wettable powders, seed disinfectants, liquid formulations emulsions, suspensions, etc., aerosols and sprays.	8	5

Reference Books:

P. N. Nene, Y. L. Thapliyal , Fungicides in Plant Disease Control, Medtech (2017).

H. Panda,The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, National Institute of Industrial Research (2003).

Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)

J. P. Kumar and S. Bharat "Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016)

C.T. Lacal, Plant growth regulators, Arcler Education Inc (2017).

E. E. Fletcher, R. C. Kirkwood, Herbicides and Plant Growth Regulators, Methuen (1981).

C.L .Foy, C. L. (ed.) Adjuvants for Agrichemicals, CRC Press, Boca Raton, FL. (1992).

e-Learning Source:

https://youtu.be/lJEeGMMcYCI?si=zWbjZmKMWy8aZQfg

https://youtu.be/lH_8N9HRsys?si=oPAAVp0XdxyG1t4A

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https://youtu.be/PEoCQEW62kU?si=U-BvRjgheL6I_dQl

https://youtu.be/snpTwZMsf1U?si=q1U08gr2XrDmPoEl

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

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDGs 2, 8, 12

Effective from Session: 2024-2025							
Course Code	B190611P/CH352	**Title of the Course**	Analysis of Agrochemicals	**L**	**T**	**P**	**C**
Year	Third	**Semester**	Six	**0**	**0**	**4**	**2**
Pre-Requisite	Diploma	**Co-requisite**	-				
Course Objectives	The chemistry lab for this course is designed to provide students with detailed knowledge of the isolation, estimation, and formulation of pesticides.						

Course Outcomes	
CO1	Students would be able to perform and evaluate the isolation of active ingredients in commercially available insecticide formulations.
CO2	Students would be able to analyze the estimation of active ingredients in commercially available insecticide formulations.
CO3	Students would be able to understand the preparation of selected pesticide formulations.
CO4	Students would be able to develop a basic knowledge of the estimation of pesticide residues in food.
CO5	Students would be able to remember and understand the comprehension of different isolations of nicotine.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Estimation of insecticide	Isolation and estimation of active ingredients of commercially available insecticide Formulations.	12	1,2
2	Formulations of pesticide	Preparation of selected pesticide formulations in the form of dusts, emulsions, sprays.	12	3
3	Estimation of pesticide in food	Estimation of pesticide residues in food articles	12	4
4	Isolation of nicotine	Isolation of nicotine from tobacco leaves/ wastes or Tea leave	24	5

Reference Books:

B. S. Furniss, A.J. Hannaford, P.W. G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).

Lab manual 11, FSSAI Manual of methods of analysis of foods https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/PESTICIDE_RESIDUE.pdf

D. A. Knowles, Chemistry and technology of agricultural formulations. Kluwer Academic, London (1998).

S. Ippolito, J. R Mendieta, Formulations of Agrochemicals, Scitus Academics Llc (2020).

A. Knowles, Chemistry and Technology of Agrochemical Formulations, Springer, 1998.

e-Learning Source:

https://youtu.be/eiO-Cqzqd04?si=-nRB3a_5Monq-35p

https://www.youtube.com/live/tc8BhEPj9b0?si=0yZ5n9xREkOg0eCT

https://youtu.be/QYXSbcfIL4c?si=vd92YF4-iYKiXczP

	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	3	2		1	2	2
CO2	2	2				1	2	1		2	2	2
CO3	1	1				2	3	2		1	1	1
CO4	2	2				1	2	2		2	2	2
CO5	3	3				3	3	1		3	3	3

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

SDG 3

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 tetraoxide. 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 nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. 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, nitrities), 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., Guiliano, 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/
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm https://nptel.ac.in/courses/104/103/104103071/#

	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**

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 andits 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 functionof 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 Helmhotz 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, specificconductance molar and equivalent conductance, measurement of equivalent conductance, variationof 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. Definitionof pH and pKa , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel 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 isothermand surface excess; Heterogenous 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 diagramdepicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantumyield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.	6	4
8	Radiochemistry	Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutromemission, positrom emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal 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-99mTc 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:
https://www.mooc-list.com/tags/physical-chemistry
https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
https://www.coursera.org/learn/physical-chemistry

	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
CO2	3	3	-	-	-	-	2	3	-	-	2	3
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**

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(dimethylgloxime) 3. Analysis of Ba asBaSO4	15	1
2	Paper Chromatography	Ascending and Circular Rf 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 monosaccharaides 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 Rf 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

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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	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**