BTech in Industrial Chemistry, Department of Chemistry, IIT Hyderabad

Course No	Sem-I	Credits	Type
IC1010	Industrial Organic Chemistry-I	3	BS
CY1010	Environmental Chemistry	2	BS
MA1110	Calculus-I	1	BS
MA1220	Calculus-II	1	BS
EP1118	Maths for Physics	2	BS
ID1063	Introduction to Programming Theory	3	BE
	Introduction to Programming LAB		
ID1041	Engineering Drawing	2	BE
LA1760	English Communication	2	SS
	Total	**16**	

Course No	Sem-II	Credits	Type
IC1030	Introduction to Systematic Inorganic Chemistry & Applications	3	DC
CY1031	Chemistry Lab	2	BS
IC1040	Thermodynamics-I	3	DC
IC1050	Introduction to Quantum Chemistry	2	DC
IC2080	Transport Properties	2	DC
MA1140	Elementary Linear Algebra	1	BS
MA1150	Differential Equations	1	BS
ID1050	Introduction to AI	1	BE
EM3020	Introduction to Entrepreneurship	1	SS
	LA/CA	1	SS
	Total	**17**	

Course No	Sem-III	Credits	Type
IC2010	Industrial Organic Chemistry-II	3	DC
IC2020	Introduction to Biochemistry	2	DC
IC2011	Basic Industrial Techniques Lab	2	DC
IC2030	Thermodynamics-II	3	DC
MA2110	Introduction to Probability	1	BS
ME2240	Fluid Mechanics-I	3	BE
ID1171	Fabrication Lab	2	BE
LA1770	Personality Development	1	SS
	LA/CA	1	SS
	Total	**18**	

Course No	Sem-IV	Credits	Type
IC2040	Food Technology	2	DC
IC2021	Synthesis and separation lab	2	DC
IC2050	Coordination Chemistry and Study of Transition Metal Complexes	2	DC
IC3040	Spectroscopy and Applications	2	DC
IC2070	Polymer Science-I	3	DC
ME3110	Heat and Mass Transfer	3	BE
	Department/Free Elective**	3	FE/DE
	Total	**17**	

Course No	Sem-V	Credits	Type
IC3010	Material Science-I	3	DC
IC2060	Petroleum and Petrochemicals	2	DC
IC3013	Numerical and Computational Chemistry (Theory+Lab)	3	DC
IC3020	Electrochemical Energy Conversion	3	DC
IC3030	Chemical Kinetics and Surface Chemistry	3	DC
	Dept/Free Elective**	2	DE/FE
IC3011	Industrial Chemical methods Lab	1	DC
	Total	17	

Course No	Sem-VI	Credits	Type
IC3405	Internship/BTech Project	6	DC
ICxxxx	Dept Electives**	3	DE
	Free electives**	3	FE
	LA/CA	2	SS
	Total	14	

Course No	Sem-VII	Credits	Type
IC4010	Introduction to Drug Design	2	DC
IC4011	Techniques in Industrial Chemistry Lab	2	DC
IC4020	Materials Science-II	3	DC
IC4030	Polymer Science-II	3	DC
ICxxxx	Dept elective**	2	DE
	Free elective**	2	FE
IC4016	Industry Lecture Series	1	DC
	Total	15	

Course No	Sem-VIII	Credits	Type
IC4040	Industrial Pollution and Chemical Industrial safety	3	DC
IC4050	Chemical Industrial separation techniques	2	DC
ICxxxx	Dept elective**	2	DE
	Free elective**	2	FE
	Free elective**	2	FE
ID4006	Ethics and values	2	SS
	Total	13	

****The department electives and free elective credits indicated in each semester are only suggestions, the students are free to do these courses in other semesters.**

List of Departmental Electives

Course No	Department Electives:	Credits	Tentative Sem
IC3023	Machine Learning in Chemistry (Theory+Lab)	2	V
IC3033	MATLAB and Mathematical Computation	2	V
IC4120	Batteries and Fuel cells	2	V
IC3060	Advanced Inorganic Chemistry	3	VI
IC3070	Heterogeneous Catalysis	3	VI
IC4130	Nuclear Chemistry	2	VI
IC4060	Molecular Spectroscopy	2	VII
IC4070	Metals in Biological Systems/Biochemical Processes	2	VII
IC4080	Synthetic Methodology in Organic Chemistry	2	VII
IC4100	Statistical Methods in Chemical Industry	2	VIII
IC4110	Introduction to Toxicology	2	VIII
IC4140	Medicinal Chemistry	3	VIII

Course Syllabus

Semester I:

Fields	Values
Date	27/03/22
Course Code	IC1010
Course Name	Industrial Organic Chemistry-I
Credits	3
Pre-requisites (if any)	Not
Nature of Course	Theory
Type of Course	core
Targeted Program and year	BTech 1 and II
Contents	Chemical process industry: Introduction, Overview and current status, Raw materials, manufacturing and engineering, Introduction to different industries by taking relevant examples. Basic products of industrial syntheses (Suitable examples: Methanol, Formaldehyde and Formic acid etc.), Pharmaceuticals (Classifications, Aspirin, Paracetamol, Ibuprofen, morphine etc.), Food chemicals (Vitamins, Food additives and preservatives), Agrochemicals (Suitable examples: Fertilizers, Pesticides, Herbicides etc.), Plastic (Suitable examples: bioplastics, thermoplastics etc.).
References	1. Industrial Organic Chemistry by Klaus Weissermel and Hans-Jurgen Arpe, 2003 WILEY-VCH Verlag GmbH & Co. KGaA 2. Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat AIi, Bassam M. El AIi, James G. Speight, 1st ed. New York: McGraw-Hill Education 3. Industrial Organic Chemistry by Mark A. Banvenuto, Berlin; Boston: De Gruyter 2017
Course Objective	The course intends to expose the students with the fundamentals of industrial chemistry related to different industrial backgrounds.
Justification:	The course is designed in such a way that the student will learn about the synthesis and applications of common chemicals used in industrial setup.

Semester II:

Fields	Values
Date	27/03/22
Course Code	IC1030
Course Name	Introduction to Systematic Inorganic Chemistry & Applications
Credits	3
Pre-requisites (if any)	not
Nature of Course	theory
Type of Course	core
Targeted Program and year	BTech 1 and II
Contents	• Acids and bases: classification, Lewis acid and base concept, hard acid, hard base classification, Pearson's HSAB concept and application; Oxidation and reduction: redox reactions, redox potential, • Electrochemical series, use of electrochemical series; • Metallic chains, sheets and clusters; Metal silicates, zeolites and polyoxo-metallates; Metals and alloys, ceramic materials, intermetallic compounds and zintl phases; • Chemistry of phosphorus, phosphorus oxides and phosphorus hydrides; Chemistry of oxyacids and oxyanion of nitrogen and phosphorus; Differences between the chemistry of nitrogen and phosphorus; Chemistry of the halogens: pseudo-halogen, inter-halogen; Oxides and oxyacids; Polyhalides; • Chemistry of the rare gases: Chemistry of xenon, structure and bonding of xenon compounds; • Non-aqueous solvents: types of solvents, general characteristics, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.
References	1. N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Ed., London: Butterworth Heinmann, 1997. 2. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, 1999.
Course Objective	The course intends to expose the students to the fundamentals of introductory inorganic chemistry related to different industrial backgrounds.
Justification:	The course is designed in such a way that the student will learn about the synthesis and applications of a wide variety of inorganic compounds such as inorganic oxides, halides, oxoacids, hydrides, metals, intermetallics, etc. Many of these compounds are industrially important and have a wide variety of applications.

Fields	Values
Date	27/03/22
Course Code	IC1040
Course Name	Thermodynamics-I
Credits	3
Pre-requisites (if any)	not
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech 1 and II
Contents	Thermodynamic properties and equilibrium, concepts of heat and work, zeroth law of thermodynamics; concept of temperature, energy and various forms of energy; internal energy, enthalpy; specific heats; first law applied to elementary processes, closed systems and control volumes, steady and unsteady flow analysis. Second Law of Thermodynamics, Carnot cycle and Carnot principles/theorems, Clausius inequality and concept of entropy; microscopic interpretation of entropy, the principle of increase of entropy, T-S diagrams; second law analysis of control volume; availability and irreversibility; third law of thermodynamics; Properties of Pure Substances; P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, ideal gas equation of state and van der Waals equation of state; law of corresponding states, compressibility factor and generalized compressibility chart.
References	Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler, 11the edition, 2018 Physical Chemistry by Robert G. Mortimer, 3rd edition, 2008
Course Objective	The study of thermodynamics to understand the comprehensive macroscopic theory of the behaviour of material systems
Justification:	The course is required to understand the properties and behaviour of material systems and to apply this understanding in useful ways.

Fields	Values
Date	27/03/22
Course Code	IC1050
Course Name	Introduction to Quantum Chemistry
Credits	2
Pre-requisites (if any)	Not
Nature of Course	theory
Type of Course	core
Targeted Program and year	BTech I and II
Contents	The motivation for Quantum mechanics: Historical background, postulates and general principles of quantum mechanics; Operators and their properties; Schrodinger equation, its application on some model systems : free-particle and particle in a box (1D and 3D), the harmonic oscillator, the rigid rotator, and the hydrogen atom; Approximate methods; Angular momentum: Eigenfunctions and eigenvalues of angular momentum operator, Spin- Pauli Principle; Born-Oppenheimer approximation; VB and MO theory, Application to H_2^+, H_2 molecule
References	Quantum Chemistry by I. N. Levine, 7th edition, 2014 Quantum Chemistry by McQuarrie, 1st (viva student) edition, 2018 Physical Chemistry by Peter Atkins, Julio de Paula and James Keeler, 11the edition, 2018
Course Objective	Understanding the development and uses of quantum mechanics to understand dynamics of chemical structures and bonding.
Justification:	The course is designed to discuss the quantum mechanical description of structure and bonding.

IC2080

Fields	Values
Date	27/03/22
Course Code	IC2080
Course Name	Transport Properties
Credits	2
Pre-requisites (if any)	not
Nature of Course	theory
Type of Course	core
Targeted Program and year	BTech I and II
Contents	Introductory remarks on transport properties, The general equation for transport, Thermal conductivity in a gas, Collisions in a gas; The mean free path, Final expression for the thermal conductivity, Viscosity, Molecular diameters, Diffusion, Summary of transport properties in a gas, The non-steady state, The Poiseuille Formula, The viscosimeter; Electrical transport; Conduction in metals, The Hall effect, The electrical current in ionic solutions, The measurement of conductivity in electrolytic solutions, The migration of ions; Transference numbers; Molar ion conductivities; Applications of conductance measurements; Stokes's law; Conductivities of the hydrogen and hydroxyl ions; Temperature dependence of the ion conductivities
References	Physical Chemistry by G. W. Castellan, 3rd edition, 1983 Physical Chemistry by Robert G. Mortimer, 3rd edition, 2008
Course Objective	Understanding of various transport phenomena of charged and neutral particles in gas, liquid phases
Justification:	The course is designed to provide fundamentals of transport phenomena, including charge transfer, mass transfer, and energy transfer processes. The course is essential many chemical industrial processes.

Semester III:

Fields	Values
Date	27/03/22
Course Code	IC2010
Course Name	Industrial Organic Chemistry-II
Credits	3
Pre-requisites (if any)	IC1010
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech-III
Contents	Industrially relevant Vinyl-Halogen and Vinyl-Oxygen Compounds (Vinyl chloride, Vinylidene Chloride, Vinyl Fluoride, Trichloro- and Tetrachloroethylene, Vinyl Esters and Ethers etc.), Components for the synthesis of polyimides (various dicarboxylic acids and diamines, Lactams etc.), Industrially relevant chemicals derived from propene (Oxidation of propene, Acrolein, Allyl compounds, Acrylonitrile etc.), Industrially relevant Aromatics Production and Conversion, Industrially relevant benzene derivatives (Alkyl benzenes, Styrene, Phenol, Aniline etc.), Industrially relevant compounds derived from Oxidation of Xylene and Naphthalene (Phthalic Anhydride and Esters of Phthalic Acid and Derivatives)
References	1. Industrial Organic Chemistry by Klaus Weissermel and Hans-Jurgen Arpe, 2003 WILEY-VCH Verlag GmbH & Co. 2. Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat AIi, Bassam M. El AIi, James G. Speight, 1st ed. New York: McGraw-Hill Education 3. Industrial Organic Chemistry by Mark A. Banvenuto, Berlin; Boston: De Gruyter 2017 4. Modern Carbonylation Methods by Prof. László Kollár, 2008 Wiley-VCH Verlag GmbH & Co.
Course Objective	To provide comprehensive knowledge of industrially relevant chemical transformations.
Justification:	The course is designed to provide extensive knowledge of synthesis and applications of chemicals used in the industrial sector.

Fields	Values
Date	27/03/22
Course Code	IC2020
Course Name	Introduction to Biochemistry
Credits	2
Pre-requisites (if any)	none
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech
Contents	Structure, properties and reactions of mono- and di-saccharides; physicochemical properties of amino acids and peptides; structural features of proteins, nucleic acids, lipids, steroids, terpenoids, carotenoids, and alkaloids. Protein folding / misfolding and function; Enzyme kinetics, regulation and inhibition; Bioenergetics and metabolism
References	1. Biochemistry by Raymond S. Ochs & Lehninger Principles of Biochemistry, 8th Edition, 2014 2. Biochemistry by Stryer et. al. 9th edition, 2019
Course Objective	The course aim to teach the basics of biochemistry and prepare them for modern pharmacological applications
Justification:	Understanding the fundamentals of biochemistry is prerequisite for the advance level applications in drug design and development.

Fields	Values
Date	27/03/22
Course Code	IC2011
Course Name	Basic Industrial Techniques Lab
Credits	2
Pre-requisites (if any)	None
Nature of Course	Lab
Type of Course	Core
Targeted Program and year	BTech II and BTech III
Contents	Experiments in Physical and Inorganic Chemistry covering first order and second order kinetics, activation energy, Freundlich adsorption, conductometric and pH metric titrations, distribution coefficient and equilibrium constant determination, phase diagram of a three-component system, viscosity determination, study of systems with lower and upper Critical Solution Temperature.
References	Manuals and references will be provided from the chemistry lab 1. Peter Atkins, P., and J. De Paula. Atkins' physical chemistry. OUP Oxford, 2014. 2. Allen J., Bard and Larry R. Faulkner. " Electrochemical methods-Fundamentals and applications." Wiley, 2000.
Course Objective	To gain hands-on experience and practical realisation for the theoretical work To apply the basic knowledge on model systems to extract various physicochemical parameters
Justification:	Laboratory course provides ultimate experience to the students. Theoretical knowledge can be justified by performing laboratory experiments and to realize the deviations from the ideal behaviour under real conditions

Fields	Values
Date	27/03/22
Course Code	IC2030
Course Name	Thermodynamics-II
Credits	3
Pre-requisites (if any)	IC1040
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II and III
Contents	Thermodynamic Relations, T-ΔS relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibility, Clapeyron and Clapeyron-Clausius equations. Thermodynamic Cycles: Carnot vapor cycle, ideal Rankine cycle, Rankine reheat cycle, air-standard Otto cycle, air-standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle, Ideal Gas Mixtures Dalton's and Amagat's laws, properties of ideal gas mixtures, air-water vapor mixtures and simple thermodynamic processes involving them; specific and relative humidities, dew point and wet bulb temperature, adiabatic saturation temperature, psychrometric chart.
References	Thermodynamics and its Applications" by J W Tester and M Modell Thermodynamics: An Engineering Approach" by Michael A Boles Fundamentals of Engineering Thermodynamics" by M J Moran and H N Shapiro
Course Objective	Various thermodynamic relations, thermodynamical cycles, thermodynamical process, and applications
Justification:	The course is designed for students to gain knowledges on various thermodynamical cycles, and relations. The implications of the same is highly sought after in chemical industrial processes.

Semester IV

Fields	Values
Date	27/03/22
Course Code	IC2040
Course Name	Food Technology
Credits	2
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II
Contents	Carbohydrates: structure and functional properties of mono-, oligo-, & poly- saccharides including starch, cellulose, pectic substances and dietary fibre. Proteins: classification and structure of proteins in food. Lipids: classification and structure of lipids, rancidity, polymerization and polymorphism. Food flavours: terpenes, esters, aldehydes, ketones and quinines. Nutrition: balanced diet, essential amino acids and essential fatty acids, protein efficiency ratio, water soluble and fat-soluble vitamins, role of minerals in nutrition, co-factors, anti-nutrients, nutraceuticals, nutrient deficiency diseases.
References	Food Chemistry, 4th edition, Belitz, H.-D., Grosch, Werner, Schieberle, Peter. Springer-Verlag Berlin Heidelberg, 2019 Principles of Food Chemistry, 4th edition, by deMan, J.M., Finley, J., Hurst, W.J., Lee, C. Springer International Publishing, 2018
Course Objective	To understand the food composition along with its physicochemical, nutritional, microbiological and sensory aspects. Processing and preservation of plant and animal foods; cereals, pulses, oilseeds, fruits vegetables, spices, meat, fish, poultry, sea food, milk and dairy products. Food safety, quality management and international food laws and regulations as well as importance of food engineering and packaging in food industry
Justification:	The course contents have been so crafted that it can keep pace with the rapidly growing food industry

Fields	Values
Date	27/03/22
Course Code	IC2021
Course Name	Synthesis and Separation Lab
Credits	2
Pre-requisites (if any)	none
Nature of Course	Lab
Type of Course	core
Targeted Program and year	Btech
Contents	1) Separation of mixtures by Chromatography: Measure the R_f value in each case; a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography b) Identify and separate the sugars present in the given mixture by paper chromatography; 2) Synthesis of common industrial compounds involving two step reactions, (e.g. 4- bromo aniline, or 3-nitroaniline, or 4-amino benzoic acid, or 4-nitro benzoic acid) 3) Preparation of paracetamol and its analysis; 4) Preparation of sulphacetamide of sulphonamide and its analysis; 5) Preparation of oils of winter green and its analysis; 6) Determination of ascorbic acid in vitamin C tablets by iodometric or coulometric titrations. 7) Separation of a mixture of dyes by column chromatography; 8) Determination of alcohol contents in liquid drugs/galenical.
References	1. Vogel's Textbook of Practical Organic Chemistry, 5th Ed. A. Vogel, et al., 1989 2. Working Manuals will be provided from the chemistry lab.
Course Objective	To gain hands-on experience and practical training
Justification:	The students will be exposed to the synthesis tools and techniques

Fields	Values
Date	27/03/22
Course Code	IC 2050
Course Name	Coordination Chemistry and Study of Transition Metal Complexes
Credits	2
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II
Contents	•Crystal field theory, Splitting of d orbitals in linear, triangular, tetrahedral, square planar, trigonal bipyramidal, square pyramidal, octahedral and pentagonal bipyramidal fields of similar and dissimilar ligands. • Crystal field stabilization energies in weak field and strong field environments, octahedral site preference energy, tetragonal distortion and Jahn Teller effect. Shapes of complexes. Effect of crystal field stabilization on ionic radii, lattice energy, hydration enthalpy and stability of complexes (Irving Williams order). Kinetic aspects of crystal field stabilization, crystal field activation energy, labile and inert complexes. •Electronic spectra of metal complexes – determination of free ion terms of d^1 to d^9, microstates, determination of ground and all excited state terms of d^n terms in octahedral and tetrahedral fields, • Orgel diagrams (qualitative approach), hole formalism, inversion and equivalence relations, selection rules for spectral transitions, d-d spectra and crystal field parameters, Nephelauxetic series, qualitative idea of Tanabe–Sugano diagrams, charge transfer spectra. Magnetic properties – elementary idea.
References	1. Concepts and Models of Inorganic Chemistry (3rd Edition)– Douglass, McDanniel & Alexander, 2006 2. Physical Inorganic Chemistry: A Coordination Chemistry Approach (1998)– S. F. A. Kettle, 3. Inorganic Chemistry, 4th Edition (2012) by Catherine Housecroft and, Alan Sharpe
Course Objective	Introduction to the fundamentals of transition metal and coordination chemistry
Justification:	This course is designed to provide basic concepts of transition metals and coordination compounds. It will build a foundation for students to learn advanced concepts of inorganic chemistry relevant to various industrial processes at later stages of the BTech program

Fields	Values
Date	27/03/22
Course Code	IC3040
Course Name	Spectroscopy and Applications
Credits	2
Pre-requisites (if any)	none
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II, III, IV, MSc
Contents	General aspects of spectroscopy, Fundamentals and applications of the following methods: Nuclear Magnetic Resonance Spectroscopy: NMR phenomenon, spin 1/2 nuclei, 1H, 13C, 19F and 31P, Zeeman splitting, Boltzmann distribution, effect of magnetic field strength on sensitivity and resolution. 1H-NMR, chemical shift, anisotropic effects, chemical and magnetic equivalence, coupling constants. Karplus relationship of J on dihedral angle, first order splitting patterns and structure correlation. 13C NMR - natural abundance, sensitivity. NOE effects, 13C chemical shifts and structure correlations. IR spectroscopy: Basic principles of IR spectroscopy, functional group frequencies of various classes of organic compounds. Factors affecting the group frequencies. UV-Vis spectroscopy: basic principles, Electronic levels and types of electronic transitions in organic, effect of extended conjugation and Woodward-Fieser rules for calculation of absorption maximum. Mass spectrometry: Introduction, Basic principle, Instrumentation, isotope abundance, molecular ions, fragmentation processes of organic molecules and deduction of structural information. Problem on structure elucidation of organic compounds based in spectral data.
References	1. Silverstein, Bassler and Morill: Spectrometric identification of organic compounds, 8th edition, 2015 2. Willim Kemp: Organic spectroscopy, 3rd edition, 1991 3. Pavia, Lampman, Kriz, Vyvyan: Introduction to Spectroscopy, 5th edition, 2015
Course Objective	To train the students for the structural analysis of the synthetic compounds
Justification:	The student will learn the fundamentals of characterization tools and techniques

Fields	Values
Date	27/03/22
Course Code	IC2070
Course Name	Polymer Science-I
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II and III
Contents	• Classification of polymers, Kinetics of polymerization, • Molecular weight of polymer and its determination, Some specific methods for molecular weight determination of biopolymers- gel filtration, SDS-PAGE for proteins, Agarose gel method for nucleic acids. • Thermodynamics of polymer solution: Polymer conformation. Molecular weights and molecular weight distributions and their determinations (viscometry, osmometry, light scattering, size-exclusion chromatography; • Principles of macromolecular synthesis: step-growth vs. chain-growth polymerizations. • Advanced synthetic techniques for controlling molecular weight dispersity in synthetic polymers- Living polymerization (living ionic, living radical and living ring-opening polymerizations); block copolymers-synthesis, microstructure, and applications; Conjugated polymers and their electrical and opto-electronic properties.
References	Principles of Polymer Chemistry, P.J. Flory, 2nd ed. 2000 Polymer Science and Technology, Robert O. Ebewele, CRC Press, Illustrated edition, 2000
Course Objective	The aim of the course is to provide information an instructional pathway of polymer materials, characterization and applications of various polymer materials.
Justification:	Polymer science course is designed for an individual to prepare for employment or continued education in the occupations of plastics and polymer materials manufacturing and hands-on experiences related to the application of polymer science concepts in the workplace.

Semester V

Fields	Values
Date	27/03/22
Course Code	IC3010
Course Name	Material Science-I
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II, III and IV
Contents	The course is designed to introduce fundamentals on solid-state materials that are suitable for applications to engineering systems. Course content: 1. Translational symmetry, Bravais lattices, point & space group, Miller indices (planes and directions), basic concepts of powder & single-crystal X-ray and neutron diffraction; 2. Crystal chemistry of important solid-state structure types; 3. Bonding in solids, Pauling's Rules, Bond Valence concept; 4. Point, line, planar, and bulk imperfections in crystalline solids 5. Introduction to Nano (nanocrystalline solids); 6. Synthetic methodologies to prepare bulk and nanocrystalline solids 7. Electrical properties of solids. 8. Band theory: metals, insulators, and semiconductors. 9. Bandgap engineering, doping, and semiconductor devices.
References	(a) Solid-state chemistry and its applications by Anthony R. West , John Wiley & Sons, 2nd Edition, 2007 (b) Solid-state chemistry: an introduction by Lesley Smart and Elaine Moore, CRC Press, 4th Edition, 2012 (c) Elements of X-ray diffraction by B. D. Cullity, Pearson Education (US), 3rd International Ed, 2003
Course Objective	To introduce to the world of Materials To gain knowledge on the structural aspects of materials To overview on the trend of emerging nanomaterials To understand the structure-property relationships of materials
Justification:	From the stone age to the silicon age, materials contributed to the development of human civilization. Students must need to acquire knowledge on the synthesis of materials and their structural aspects leading to the functional properties. The current era of nanomaterials is no exception and advancement towards development of new materials continues to expand.

Fields	Values
Date	27/03/22
Course Code	IC3013
Course Name	Numerical and Computational Chemistry (Theory+Lab)
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II, III and IV
Contents	Programming principles using loops, arrays and functions; use of libraries; Numerical methods: truncation and round off errors; roots; interpolation; differentiation and integration; linear equations, matrix operations; curve fitting; ODEs; optimization; Application of numerical methods to chemical problems. Computational chemistry: A brief outline of molecular mechanics, semi-empirical approximations, ab initio methods, Density Functional Methods, basis sets, and Z-matrix; Application of these computational methods for prediction of structural and electronic properties of molecules, solid-state materials by using standard programs; computation of potential energy surfaces. Conformational analysis by molecular mechanics; Dynamical and structural studies of molecules using molecular dynamics simulations; Monte Carlo simulations of molecules; Molecular Docking Techniques.
References	Fortran 90/95 for Science and Engineering, edition 2, S.J. Chapman, McGraw Hill Introduction to Numerical Computation, L. Eldén, L. Wittmeyer-Koch, H.B. Nielsen, J. Cramer, Essentials of Computational Chemistry: Theories and Models J. B. Foresman, A. Frisch, Exploring Chemistry with Electronic Structure Methods. R. Dronskowoski, R. Hoffmann, Computational Chemistry of Solid-state materials: A Guide for Material Scientists, Chemists, Physicists, and others.
Course Objective	The course is designed to solve practical problems using numerical and computational methods.
Justification:	The course is to give students the practical method of generating a program to solve industrial chemistry problems.

Fields	Values
Date	27/03/22
Course Code	IC3020
Course Name	Electrochemical Energy Conversion
Credits	3
Pre-requisites (if any)	IC3060, IC3011
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech (III or IV), M.Sc
Contents	This course gives an insight to fundamental of electrochemistry; corrosion and electrodeposition of metals from the aspect of electrochemistry and the course will provide comprehensive exploration of all types of batteries and fuel cells and their applications. Contents: Electrochemical cell - redox reaction, origin of electrode potential, Standard Hydrogen Electrode, EMF series, Reference electrodes, Concentration cells, Liquid Junction Potential, Applications of EMF, Conductivity of electrolyte solutions, Activity, Activity coefficient, Debye - Huckel - Onsager Equation, Kinetics- Over-potential, Butler Volmer equation, Tafel equation. Corrosion: Basics, chemical and electrochemical corrosion, corrosion control, Electrodeposition. Principles of Operation of Cells and Batteries; Electrochemical Principles and Reactions; Factors Affecting Battery Performance; Battery Design; Primary cells and Batteries; Fundamentals of Secondary Batteries: Advanced Lead-acid, Ni-based and lithium-ion batteries, next generation batteries, Materials for batteries, Electrode preparation, cell Assembly, electrochemical performance analysis, understanding of degradation mechanism and Safety. Fuel cells: Introduction to Fuel Cells: working principle, direct methanol fuel cells, Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate Fuel cells. Advanced batteries and fuel cells for UPS, Solar, Telecom, Aerospace, Grid and Electric Vehicle applications.
References	1. Peter Atkins, P., and J. De Paula. Atkins' physical chemistry. OUP Oxford, 11th Edition, 2019. 2. Allen J., Bard and Larry R. Faulkner. " Electrochemical methods-Fundamentals and applications." Wiley, 2nd Edition, 2000. 3. John O'M. Bockris, Amulya, K.N. Reddy, Maria E. Gamboa-Aldeco, Modern Electrochemistry 2A, Fundamentals of Electrodics, 2nd Edn, 2006. 4. T. Ohtsuka, A. Nishikata, M. Sakairi, K. Fushimi, Electrochemistry for Corrosion Fundamentals, Springer, 2006. 5. Kirby W. Beard. Linden's Handbook of Batteries, Fifth Edition (McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto, 2019). 6. Vladimir S. Bagotsky, Alexander M. Skundin and Yury M. Volfkovich (A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Science, Nanostructured Materials for Next-Generation Energy Storage and Conversion: Advanced Battery and Supercapacitors, Springer Nature, 10-Oct-2019 - Technology & Engineering - 472 pages.

	8. D. Pavlov, Lead-Acid Batteries: Science and Technology, Elsevier 31-May-2011 - Technology & Engineering - 656 pages. 9. C. Vincent, Bruno Scrosati, Modern batteries, Elsevier, 26-Sep-1997 - Technology & Engineering - 368 pages. 10. Paul Breeze, Fuel cells, 2017, Elsevier Science, 100 pages. Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors" By, John Wiley & Sons Inc, New Jersey, USA, 2015, 372 pages, ISBN: 978-1-118-46023-6.
Course Objective	To understand the basics of electrochemistry To apply fundamental concepts in developing environmentally friendly energy storage devices To motivate students in exploring cutting-edge research based on advanced electrochemistry
Justification:	1) Electrochemistry has a rich historical background and the domain of applied electrochemistry is given the utmost importance. What is the essence of electrochemistry in addressing some of the pressing global issues related to energy? What kind of electrochemical approaches and methods can be suitable towards realizing the fossil-fuel free society will be discussed in this course. 2) IC3060 provides a little bit of basic electrochemical aspects, but the current course is a way advanced and would encourage students to pursue cutting-edge research problems related to electrochemical energy storage and electrocatalysis, fuel cells,etc. IC3011 provides hands-on experience in using specific electrochemical techniques to provide practical knowledge to the students.

Fields	Values
Date	27/03/22
Course Code	IC3030
Course Name	Chemical Kinetics and Surface Chemistry
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech III, IV, M.Sc
Contents	Introduction to Chemical Kinetics: Order, molecularity,1st-2nd- 3rd –nth order derivations, half-life, determining the order of reaction, the effect of Temperature, Concentration, Pressure, Catalyst on Reaction Rate, Arrhenius equation, Kinetics of nuclear reactions, reversible /opposing reactions, consecutive /successive reactions, side/parallel reactions, steady-state approximation, chain reactions, collision-transition state theory. Aggregation and self-assembly; Colloids: Classification and preparation; Structure and stability; The electrical double layer, Micelles, and biological membranes; Determination of size and shape; Mean molar masses; Laser light scattering The growth and structure of solid surfaces, The extent of adsorption; The extent of adsorption; The rates of surface processes
References	1. K. J. Laidler, Chemical Kinetics, 3rd Ed., Pearson (2003) 2. P. Atkins, J. de Paula and J. Keeler, Atkins' Physical Chemistry, 11th Ed., Oxfod University Press (2019). 3. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry of Organic Molecules, Viva Student Edition, Viva (2017). 4. J. I. Steinfel, j. S. Francisco and W. L. Hase, Chemical Kinetics and Dynamics, 2nd Ed., Prentice Hall (1999).
Course Objective	To understand the reaction kinetics of homogeneous and heterogeneous To understand the importance of surface chemistry in the heterogeneous catalysis to design certain industrial processes To apply the concepts in the better design of catalysts for mitigating pollution effects by converting harmful gases to less harmful ones.
Justification:	1) Thermodynamics provides feasibility of a reaction but kinetics provide rate at which reaction proceeds. Depending on the rate of a chemical reaction, experimental reaction conditions such as temperature and catalyst can be explored as optimal options. Most of the heterogeneous catalysis is linked to industrial processes and hence it is very important to study surface chemistry and active sites responsible for the chemical conversion. Indeed, a lot of fertilizers and chemicals are being produced industrially with the knowledge of chemical kinetics. 2) there is no overlap of this course with others and it remains the unique course

IC2060

Fields	Values
Date	27/03/22
Course Code	IC2060
Course Name	Petroleum and Petrochemicals
Credits	2
Pre-requisites (if any)	No
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech II and III
Contents	• Origin, formation and composition of petroleum, • petroleum processing: fractionation, blending of gasoline, gasoline treatment, kerosene treatment, treatment of lubes, petroleum wax and purification; • Thermal and catalytic processes: thermal cracking, catalytic cracking, catalytic reforming, naphtha cracking, coking, hydrogen processes, alkylation, isomerization processes; polymer gasoline, asphalt, upgradation of heavy crudes; • Specialty products: industrial gases, liquid paraffin, petroleum jelly; Sources of petrochemicals; Synthesis of methanol, formaldehyde, acetylene, synthetic gas, ethanol, ethylene, ethylene glycol, vinyl acetate, acrylic acid and acrylates, acrylonitrile, acetone, acetic acid, chloroprene, vinyl chloride, vinyl acetate, acrylonitrile, propylene, butadiene, butanes, isobutene, adipic acid, adiponitrile, benzene, toluene, xylene, phenol, styrene, phthalic acid, phthalic anhydride and their applications in chemical industry.
References	B. K. B. Rao, Modern Petroleum Refining Processes, 4th Ed., Oxford & IBH Publishing Co. Pvt Ltd., New Delhi, 2002. P. Wiseman, Petrochemicals, John Wiley & Sons, 1986.
Course Objective	This course provides understanding on the process of petroleum refining, fractionation processes, including crude oil distillation and light ends fractionation, distillation processes
Justification:	The course is designed to provide much needed knowledge on various chemicals and processes involved in the petroleum industry.

IC3011

Fields	Values
Date	27/03/22
Course Code	IC3011
Course Name	Industrial Chemical methods Lab
Credits	1
Pre-requisites (if any)	none
Nature of Course	Lab
Type of Course	Core
Targeted Program and year	BTech II and III
Contents	Mini-projects based on electro- and chemical- polymerization of aniline, study of the redox reactions and the different forms of PANI by cyclic voltammetry and UV-vis spectroscopy or preparation of silver nanoparticle colloids, and understanding the dependence of band ga on particle size using UV- vis spectroscopy, electrodeposition of Ni / NiOx films and study of their electrochemical and optical properties. References: Manuals and references will be provided from the chemistry lab
References	reference manual will be provided
Course Objective	Planning, preparation and execution of small scale industrial chemistry experiment
Justification:	To develop independent thinking skill, the course is designed.

Semester VII

Fields	Values
Date	27/03/22
Course Code	IC4010
Course Name	Introduction to Drug Design
Credits	2
Pre-requisites (if any)	none
Nature of Course	theory
Type of Course	
Targeted Program and year	BTech-4 year, MSc
Contents	Principles of Drug Discovery, Targets for drug discovery, and Identification of Lead Compounds; Physiochemical Properties of Drugs (Absorption, Distribution, Metabolism); Drug Receptor interactions; enzymes as drug targets, Drug design strategies, Structure-Based Drug Design; Use of chemoinformatics in drug design, Strategies for Organic Drug Synthesis; Combinatorial Chemistry; Prodrugs and drug delivery systems, Illustration of drug development through specific examples, Drug resistance, Drug synergism and combination therapy.
References	References: 1) Chemical Engineering in the Pharmaceutical Industry: Drug Product Design, Development, and Modeling by Mary T. am Ende (Editor), David J. am Ende (Editor). Wiley 2) Burger's Medicinal Chemistry, Drug Discovery and Development, 8 Volume Set. Volumes 1 – 8 Donald J. Abraham School of Pharmacy, Virginia Commonwealth University, Richmond, Virginia. 3) Silverman, R. B., The Organic Chemistry of Drug Design and Drug Action, 2nd Edition, 2004, ISBN: 0-12-643732-7, Academic Press 4) Organic Medicinal and Pharmaceutical chemistry. By Wilson and Gisvold's (English, Paperback, Beale John M) 5) Williams, D. A.; Lemke, T. L., Foye's Principles of Medicinal Chemistry. 5th ed.; Wolters Kluwer Health (India) Pvt. Ltd.: 2006.
Course Objective	To update the students regarding drug development tools and techniques
Justification:	The students will be taught about the rationale behind the drug design and development

Fields	Values
Date	27/03/22
Course Code	IC4011
Course Name	Techniques in Industrial Chemistry Lab
Credits	2
Pre-requisites (if any)	None
Nature of Course	Lab
Type of Course	Core
Targeted Program and year	B. Tech. (III and IV)
Contents	• Synthesis and characterization of inorganic compounds in the diverse areas of Inorganic Chemistry such as Coordination Chemistry, • Organometallic Chemistry and Bioinorganic Chemistry etc. Characterization: • quantitative and qualitative determination of ligand and metal, use of spectral techniques (UV-visible, FT-IR, NMR, ESR, magnetic moment, analytical methods (conductance, TGA, DSC, cyclic voltammetry).
References	1. Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual, Gregory S. Girolami, Thomas B. Rauchfuss and Robert J. Angelici. University Science Books. 2. Synthetic methods of organometallic and inorganic chemistry ed. by Wolfgang A. Herrmann, Georg Thieme Verlag, New York, 1997, Vol 7 and 8 3. 3. Vogel's qualitative inorganic analysis, by Svehla, G. Publisher: Harlow: Longman, 1996. 4. Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis. By: Arthur Israel Vogel; John Bassett Publisher: London; New York: Longman, 1978.
Course Objective	This advanced laboratory course aims to introduce students to the experimental aspects of industrial inorganic chemistry such as synthesis and characterization of coordination, bioinorganic, and organometallic compounds.
Justification:	This practical course is required to train students in dealing with the characterization of various types of industry relevant inorganic compounds.

Fields	Values
Date	27/03/22
Course Code	IC4010
Course Name	Materials Science-II
Credits	3
Pre-requisites (if any)	IC3010
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech IV, M.Sc
Contents	The course is designed to gain in depth knowledge on the physical properties of solid-state materials and their applications to engineering systems, characterization techniques and application. Course content: 1. Magnetism & magnetic materials 2. Thermal and optical properties of solids 3. Superconductors, thermoelectric, photoconductors, solar cell, and battery materials 4. Properties of important metals oxides and chalcogenides for catalytic applications. 5. Introduction to nanoscience, nanotechnology; 6. Synthesis of Nanomaterials by Physico-chemical approaches. 7. Advanced Characterization Methods: X-ray diffraction and Microscopy methods, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, X-ray photoelectron spectroscopies, Raman spectroscopies. 8. Application of nanomaterials and safety.
References	a) G. A. Ozin and A. C. Arsenault, Nanochemistry-A Chemical Approach to Nanomaterials -, RSC Publishing, Cambridge, 2006. b) G. Cao and Y. Wang, Nanostructures and Nanomaterials-Synthesis, Properties, and Applications, 2nd Edition, https://doi.org/10.1142/7885, Pages: 596, 2011, e) Solid-state chemistry and its applications by Anthony R. West; 2014, Student edition f) Solid-state chemistry: an introduction by Lesley Smart and Elaine Moore
Course Objective	To gain knowledge on tools for characterisation of materials To understand structure-property relationships of advanced materials To study the functional properties of materials and further apply them in specific applications
Justification:	1) Materials development advances human society. New types of materials are being discovered from time and time. It is alos very important to design materials as per specific application requirement. Therefore, characterisation of materials remain core of the subject which help guide for the better design of materials with intended properties. Understanding of different physicochemical properties of materials is very much required for the rational design of smart functional devices. 2) IC 3010 deals with the structural aspects and fundamental design aspects of materials. The current course deals with the characterisation and functional properties of materials

IC4030

Fields	Values
Date	27/03/22
Course Code	IC4030
Course Name	Polymer Science-II
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech III and IV and MSc
Contents	• Commodity and general-purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE. • Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, • thermodynamics, phase morphology, • polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, • long and short fibre reinforced composites., Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, • Cross-linking and vulcanization, vulcanization kinetics. • Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. • Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. • Visco-elasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR., • Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer. • Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. • Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.
References	Principles of Polymer Chemistry, P.J. Flory, 2nd ed. 2000 Polymer Science and Technology, Robert O. Ebewele, CRC Press,Illustrated edition,, 2000
Course Objective	To understand general-purpose thermoplastics, blends and composites, rheological properties of polymers and various other properties.
Justification:	Polymer science course is designed to prepare the students for employment or continued education in the occupations of plastics and polymer materials manufacturing and hands-on experiences related to the application of polymer science concepts in the workplace.

IC4016

Fields	Values
Date	27/03/22
Course Code	IC4016
Course Name	Industry Lecture Series
Credits	1
Pre-requisites (if any)	not
Nature of Course	Seminar
Type of Course	core
Targeted Program and year	BTech III and IV, MSc
Contents	A series of lectures will be conducted at the department inviting prominent industry persons. It is mandatory for the BTech students to attend and interact with the speaker.
References	Not required
Course Objective	Seminars for students to be familiarize with industry updates
Justification:	Seminars for students to be familiarize with industry updates

Semester VIII

Fields	Values
Date	27/03/22
Course Code	IC4040
Course Name	Industrial Pollution and Chemical Industrial safety
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	BTech III and IV
Contents	CPCB Guidelines, Air and Noise Pollution, Water pollution- ASP, ETP, etc Solid Waste Emission and control methods in the Production of Sulfuric Acid, Production of Nitrates-Containing Fertilizers, Lime Production, Soda Production, NaOH/Cl2 by electrolysis, Cement, Pharmaceutical Industry, Bulk Organic Chemical Industry Water Pollution: Identification, quantification and analysis of wastewater, Classification of different treatment methods into physico-chemical and biochemical techniques, Physico-chemical methods, General concept of primary treatment, Liquid-solid separation, Design of a settling tank, Neutralization and flocculation, Disinfection, Biological methods, Concept of aerobic digestion, Design of activated sludge process, Concept of anaerobic digestion, Air Pollution: Classification of air pollutants, Nature and characteristics of gaseous and particulate pollutants, Analysis of different air pollutants, Description of stack monitoring kit and high volume sampler, Atmospheric dispersion of air pollutants, Gaussian model for prediction of concentration of pollutant down wind direction, Plume and its behavior, Operating principles and simple design calculations of particulate control devices, Brief concepts of control of gaseous emissions by absorption, adsorption, chemical transformation and combustion. Solid Wastes: Analysis and quantification of hazardous and non-hazardous wastes, Treatment and disposal of solid wastes, Land filling, Leachate treatment, Incineration. Environmental Management System: Environment impact assessment, Its concept and constituents, Environmental audit, ISO-14000 system.
References	Hand Book of “Industrial Safety and Health, Trade and Technical Press Ltd. Morden,U.K.1980. William Handley, Industrial Safety Hand Book, McGraw-Hill Book Company 2nd Edition, 1969. Fawatt,H.H.and Wood, W.S. Safety and Accident Prevention in Chemical Operation,Interscience,1965. S.P.Mahajan, “Pollution Control in Process Industries” Tata McGraw Hill, NewDelhi1985. K.S.N.Raju, “Chemical Process industry safety” Tata McGraw Hill, NewDelhi 2006.

Course Objective	The students will learn the source, types, hazards associated to chemical industrial pollutants. The types of wastes and its effect on environment and associated hazards will be discussed.
Justification:	Students will learn guidelines on chemical safety and biosafety including risk, testing and assessment of chemicals, chemical accidents etc.

Fields	Values
Date	27/03/22
Course Code	IC4050
Course Name	Chemical Industrial separation techniques
Credits	2
Pre-requisites (if any)	Not
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	Btech III, IV, MSc
Contents	Raoult's law, distillation curves, Liquid-Liquid separation, Azeotropic distillation, Basics of Chromatography, LC, LC-MS-MS, HPLC, Detectors for HPLC, GC, detectors for GC, GC-MS-MS, GPC, IC.
References	Vogel, Arthur Israel, and George Harold Jeffery. Vogel's textbook of quantitative chemical analysis. Wiley, 1989. Industrial Separation Processes, Fundamentals by André B. de Haan, H. Burak Eral and Boelo Schuur, 2nd edition, 2020.
Course Objective	Liquid-Liquid Extraction, Industrial membrane separation technologies, Industrial Crystallization, Fixed and fluid bed full scale chromatography
Justification:	Separation processes on an industrial scale account for well over half of the capital and operating costs in the chemical industry. Knowledge of these processes is key for every student of chemical or process engineering.

List of Electives

Fields	Values
Date	27/03/22
Course Code	IC3023
Course Name	Machine Learning in Chemistry
Credits	2
Pre-requisites (if any)	
Nature of Course	Theory and Lab
Type of Course	Core
Targeted Program and year	Btech II, III, IV
Contents	Artificial intelligence (AI) rapidly changes many aspects of chemical sciences, from drug discovery, material design, and the discovery of new reactions and molecules till the acceleration of computer sciences and robotics for chemical applications. This course will cover the key aspects of AI and modern chemoinformatics and how they are applied on chemical sciences.
References	Chemoinformatics: Basic Concepts and Methods Edited by Engel and Gasteiger, (Wiley-VCH Verlag GmbH & Co., 2018). Machine Learning in Chemistry: The Impact of Artificial Intelligence, Hugh M. Cartwright, 2020, theoretical and coumputational chemistry series, volume 17.
Course Objective	The use of chemintelligence to predict the outcome of a chemical reaction is the primary objective of the course.
Justification:	Artificial Intelligence (AI) is being used more and more by chemists to perform various tasks. Originally, research in AI applied to chemistry has largely been fuelled by the need to accelerate drug discovery and reduce its huge costs and the time to market for new drugs.

Fields	Values
Date	27/03/22
Course Code	IC3060
Course Name	Advanced Inorganic Chemistry
Credits	3
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Elective
Targeted Program and year	BTech III & M.Sc I
Contents	Basic Bonding Theory, Crystal Field Theory and Molecular orbital Theory, • Molecular Symmetry and Character Tables and their Application to Vibrational and Electronic spectroscopy, Selection Rules, • Reaction Mechanism (Redox, Photochemistry, Ligand substitution reactions), • Acid-Base and Donor-Acceptor Chemistry, Magneto-Chemistry, Organometallic Chemistry and Bioinorganic chemistry. • Applications to current research problems in inorganic and solid-state chemistry.
References	1. Inorganic Chemistry by Catherine E. Housecroft and Alan G. Sharpe; Physical Inorganic Chemistry by S F A KETTLE 2. Advanced Inorganic Chemistry, 6th Edition by F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann.
Course Objective	This course aims to offer advanced aspects of inorganic chemistry including structural, bonding, reaction mechanism, spectroscopic, and magneto-characterization of the organometallic, coordination compounds, and extended inorganic solids.
Justification:	The course is designed to provide advanced concepts of inorganic chemistry, which is critical to design and fine-tune the properties of inorganic compounds relevant to industrial applications such as catalytic properties and value added inorganic materials.

Fields	Values
Date	27/03/22
Course Code	IC3070
Course Name	Industrial Heterogeneous catalysis
Credits	3
Pre-requisites (if any)	not
Nature of Course	theory
Type of Course	elective
Targeted Program and year	BTech II, III and IV
Contents	Introduction to Heterogeneous catalysis-Theory, Kinetic modelling, L-H and E-R mechanism. Electronic and Geometric factors, Industrial catalytic applications of Zeolites, Aluminophosphates, Mesoporous materials, Aminophosphates, Hydrotalcite, clays, Nanocomposites and Metal organic Frameworks. Nanoparticles for heterogeneous catalysis Catalysts Preparation Methods: Solid-Solid (Ceramic Method) Solid from Liquid-Sol-gel Method; Co-Precipitation Method; Hydrothermal Method, Chemical Vapor deposition Method. Characterization methods: Isotherm models, BET, BJH. TPD, TPD, TRP, Metal dispersion. Solid acids/bases/redox and multifunctional catalysts: Applications of Solid acids: Alkylation, Cracking, Isomerization, Aromatization, Methanol to olefin reaction. Solid basic catalysis. Solid redox catalysts: Phenol & Benzene hydroxylation, Ammoxidation, Alkane oxidation, Alcohol oxidation, Alkene epoxidation. Oxidative dehydrogenation, Electrocatalysis. Other Industrially important catalysts and processes: Wilkinson catalyst, Zeigler Natta catalyst, Fisher trope synthesis, Heck reaction, Suzuki coupling reaction, Haber process, Bio-diesel production, Photocatalysis. Enzymatic catalysis: Enzymatic catalysis, Kinetics, General Mechanism, Mechanisms for the Inhibition of Enzyme Catalysis, Advantages, LImitations, and Applications.
References	1. Catalysis: Principles and Applications, B. Viswanathan, S. Sivasanker, A.V. Ramaswamy, Narosa Publishing House, New Delhi 2007. 2. Industrial Catalysis A Practical Approach, Jens Hagen, Wiley-VCH, Verlag GmbH & Co. KGaA, 2006.
Course Objective	Heterogeneous catalysis, kinetic models, catalysts, mechanisms, examples and applications.
Justification:	Heterogeneous catalysis is the back bone of chemical industry. The course is designed to enhance the understanding of the students on the current advancements of industrial catalysts.

Fields	Values
Date	27/03/22
Course Code	IC4060
Course Name	Molecular Spectroscopy
Credits	2
Pre-requisites (if any)	not
Nature of Course	Theory
Type of Course	elective
Targeted Program and year	BTech III and IV, MSc
Contents	Region of spectrum, spectral lines intensity and broadening, Microwave spectrum of rigid and non-rigid rotator, Principle of microwave oven; Vibrational spectra of harmonic and anharmonic oscillator, Vibrations of polyatomic molecules, group frequencies and its applications, instrumental methods. Raman spectroscopy and instrumentation, structure determination; Principles of UV-VIS spectroscopy and instrumentations; Principles and methodology of spin resonance spectroscopy: NMR and ESR; Magnetic resonance imaging (MRI).
References	1. Physical Chemistry by Peter Atkins and Julio de Paula, James keeler, 11th edition, 2018 2. Fundamentals of molecular spectroscopy by Banwell, 4th edition, 2017
Course Objective	The origin of interaction between radiation and matter, fundamental of molecular energy levels, absorption, instrumentations and applications
Justification:	Analytical methods based on spectroscopy provides one of the most accurate methods. the course is designed to provide knowledge from fundamental to applications.

Fields	Values
Date	27/03/22
Course Code	IC4070
Course Name	Metals in Biological Systems and Biochemical Processes
Credits	2
Pre-requisites (if any)	None
Nature of Course	Theory
Type of Course	Elective
Targeted Program and year	BTech III and IV, M.Sc
Contents	Metal ions in biology: metallo-proteins and enzymes containing Mg, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo and W ions. heme and non-heme systems, Peptide and nucleotide hydrolytic enzymes, Metal environment, electronic, magnetic and redox properties; fixation of N2, water-oxidation reactions, Synthetic models for the structure and function of the above enzymes, syntheses of ligand-metal complexes, reactivity of O2, CO, NO, N2; mechanistic aspects, high-valent metal-oxo (Fe-, Mn- and Cu) systems, Interaction of metal ions with nucleotides and peptides, hydrolysis of phosphate and amide groups, Metal based drugs, environmental applications and toxic effects.
References	Principles Of Bioinorganic Chemistry Hardcover by Stephen J. Lippard, Jeremy M. Berg
Course Objective	This course offers fundamental aspects of the metal ions involved in biological processes, which include studying chemical, redox, electronic, and their biological properties.
Justification:	This course is designed to explore the chemistry of metals ions involved in important biological processes. This course will be useful for students to design new bioinspired molecules and to develop new routes to synthesize them in bulk scale for various important applications such as environmental remediation, green energy production, etc.

Fields	Values
Date	27/03/22
Course Code	IC4080
Course Name	Synthetic Methodology in Organic Chemistry
Credits	2
Pre-requisites (if any)	
Nature of Course	Theory
Type of Course	Elective
Targeted Program and year	BTech-VII/VIII, MSc
Contents	Basic retrosynthetic analysis: terminology associated with, prostereoisomerism, homo, enantio, diastereo ligands and faces, stereoselective synthesis. Nucleophilic C-C bond forming reactions: organometallic reagents of lithium, magnesium, copper, chromium and iron, ylides of sulfur and nitrogen, Tebbe's reagent. Enolates, kinetic and thermodynamic enolates, enolate condensation reactions like Claisen, Dieckmann, Knoevenegal, Stobbe, Darzen glycidic ester. Umpolung reagents, definition of umpolung, acyl anion equivalent, equivalents of ketene, RCOCH2+, RCOCH2CH2CH2+, RCOCH2CH2CH2- etc. C-C bond formation via free radicals and carbenes: methods of generation of free radicals and carbenes, reactions of free radicals, coupling, addition, substitution, fragmentation and rearrangements. C-C bond formation using tin reagents: Protecting groups, protection of hydroxyl, carboxyl, carbonyl, amino groups. Protection of carbon-carbon multiple bonds. Illustration of protection and deprotection in synthesis.
References	1. F. A. Carey and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th edition, Plenum Press, 2007. 2. S. Warren, Designing Organic Synthesis, John Wiley, 2009. 3. S. G. Davies, Organotransition Metal Chemistry, Application to Organic Synthesis, Pergamon Press, 1984. 4. R. K. Mackie and D. M. Smith, Guidebook to Organic Synthesis, ELBS, 1991. 5. Michael B. Smith, Organic Synthesis, McGraw Hill, 1994.
Course Objective	The students will learn the advanced organic tools and techniques
Justification:	Hardcore chemistry requires strong hold on synthetic organic chemistry

Fields	Values
Date	27/03/22
Course Code	IC4100
Course Name	Applied Statistical Methods and the Chemical Industry
Credits	2
Pre-requisites (if any)	
Nature of Course	Theory
Type of Course	Elective
Targeted Program and year	BTech III and IV, MSc
Contents	Quality of Analytical Measurements-Propagation of error, Sampling strategy, Quality control methods-property control charts, precision control charts, collaborative tests and uncertainty of measurements, Significance tests: Comparison tests, outliers, ANOVA calculations. Analytical methods Metrological Quality: Various types of analytical methods, regression analysis, Limit of detection, Limit of quantification, Random error, Calibration of equipment and instruments. Curvilinear and outlier analysis. Standard Method Development and Validation: Optimization of experimental procedures in analytical chemistry, Standard addition, External standard, internal standard and dilution methods, response surfaces, specific examples, experimental design-fractional factorial designs. Validation testing parameters and their calculation with numerical examples
References	1. Quality Assurance and Quality Control in the Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC Press, 2009 and 2nd Edition. 2. Quality Assurance in the Analytical Chemistry Laboratory, D. BrynnHibbert, Oxford University Press, New York, 2007 and 1st Edition.
Course Objective	The discipline of statistics is the study of effective methods of data collection, data summarization, and (data based, quantitative) inference making in a framework that explicitly recognizes the reality of nonnegligible variation in real-world processes and measurements.
Justification:	Handling large data and simultaneous analysis using various analytical approaches and design of standardization tools as essential for engineers in chemical industry.

Fields	Values
Date	27/03/22
Course Code	IC4110
Course Name	Introduction to Toxicology
Credits	2
Pre-requisites (if any)	not
Nature of Course	Theory
Type of Course	Core
Targeted Program and year	Btech III and IV
Contents	Students examine basic concepts of toxicology as they apply to the effects of environmental agents, e.g. chemicals, metals, on public health. We discuss the distribution, cellular penetration, metabolic conversion, and elimination of toxic agents, as well as the fundamental laws governing the interaction of foreign chemicals with biological systems. A survey of general principles underlying the effects of toxic substances on biological systems, including consideration of the history, scope and applications of toxicology, toxicant exposure, the mechanisms of toxic action, and some major types of toxicants
References	Hodgson, Ernest, ed. A textbook of modern toxicology. John Wiley & Sons, 2004. Hayes, A. W., & Kruger, C. L. (Eds.). (2014). Hayes' principles and methods of toxicology. Crc Press.
Course Objective	Training of students to obtain knowledge and practical skills in the recognition of and, through fundamental and applied research, also in the qualitative and quantitative analysis and evaluation of: Exposure of man and animal to potentially hazardous environmental factors of chemical, biological or physical nature.
Justification:	The course is designed to give practical knowledge on various hazardous effect of chemicals used in industry.

Fields	Values
Date	27/03/22
Course Code	IC4013
Course Name	MATLAB and Mathematical Computation
Credits	2
Pre-requisites (if any)	Not
Nature of Course	Combined theory and Lab
Type of Course	elective
Targeted Program and year	Btech III and IV, MSc
Contents	Variables, arrays, conditional statements, loops, functions, and plots are covered in a project-based style where much of the learning happens away from the classroom. Students are expected to spend about 4 hours per week on homework. At the end of the course, students should be able to use MATLAB in their own work, and be prepared to deepen their MATLAB programming skills and tackle other languages for computing, such as Java, C++, or Python.
References	1. MATLAB Programming for Engineers, Stephen J. Chapman, 6th edition, 2020 2. Programming for Engineers: A Foundational Approach to Learning C and Matlab, Aaron R. Bradley,1st Edition, 1998
Course Objective	To teach numerical solution to problems relevant to chemical industry and beyond.
Justification:	Engineers and scientists need a programming language that lets them express matrix and array mathematics directly. Linear algebra in MATLAB is intuitive and concise

Fields	Values
Date	27/03/22
Course Code	IC4120
Course Name	Batteries and Fuel cells
Credits	3
Pre-requisites (if any)	not
Nature of Course	theory
Type of Course	elective
Targeted Program and year	Btech III and IV, MSc
Contents	Principles of Operation of Cells and Batteries; Electrochemical Principles and Reactions; Factors Affecting Battery Performance; Battery Design; Primary cells and Batteries; Fundamentals of Secondary Batteries: Advanced Lead-acid, Ni-based and lithium-ion batteries, next generation batteries, Materials for batteries, Electrode preparation, cell Assembly, electrochemical performance analysis, understanding of degradation mechanism and Safety. Fuel cells: Introduction to Fuel Cells: working principle, direct methanol fuel cells, Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate Fuel cells. Advanced batteries and fuel cells for UPS, Solar, Telecom, Aerospace, Grid and Electric Vehicle applications.
References	1. Kirby W. Beard. Linden's Handbook of Batteries, Fifth Edition (McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto, 2019). 2. Vladimir S. Bagotsky, Alexander M. Skundin and Yury M. Volfkovich (A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Science, Russia) Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors" By, John Wiley & Sons Inc, New Jersey, USA, 2015, 372 pages, ISBN: 978-1-118-46023-6. 3. Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, Nanostructured Materials for Next-Generation Energy Storage and Conversion: Advanced Battery and Supercapacitors, Springer Nature, 10-Oct-2019 - Technology & Engineering - 472 pages.
Course Objective	This course is a guide to the evolution of the use of electrochemistry to generate energy and power.
Justification:	The course will provide comprehensive exploration of all types of batteries and fuel cells and their applications.

Fields	Values
Date	27/03/22
Course Code	IC4130
Course Name	Nuclear Chemistry
Credits	3
Pre-requisites (if any)	not
Nature of Course	theory
Type of Course	Elective
Targeted Program and year	BTech III, IV, MSc
Contents	• Nuclear Chemistry Introduction: Basic Concepts, • Elementary Particles, and Decay Types, • Nuclear Properties: Nuclear masses and binding energies, • Chemistry of Actinide and Trans-actinide elements, Radioactive decay Kinetics (α- and β-decay and γ-ray decay), Nuclear Reactions, Nuclear Fuel Cycle, and Nuclear Reactor, • Separation Techniques for the Nuclear Wastes.
References	1. Modern Nuclear Chemistry, Walter D. Loveland, David J. Morrissey, Glenn T. Seaborg, Second Edition, 2017 2. Nuclear and Radiochemistry, József Kónya and Noémi M. Nagy, Second Edition, 2018
Course Objective	The course explains the basic principles and applications of the primary areas of nuclear and radiochemistry
Justification:	The course includes nuclear medicine and chemical aspects of nuclear power plants, namely the problems of nuclear wastes and nuclear analysis, with the analytical methods based on the interactions of radiation with matter.

Fields	Values
Date	27/03/22
Course Code	IC4140
Course Name	Medicinal Chemistry
Credits	2
Pre-requisites (if any)	
Nature of Course	Theory
Type of Course	Elective
Targeted Program and year	Btech III and IV
Contents	History and development of medicinal chemistry. An Introduction to Drugs and their action – Source of drugs, classification and route of administration and drug action. Selected Examples of Drug Action at some Common Target Areas - Examples of drugs that target cell membranes, enzymes, receptors, and nucleic acids. Pharmacokinetics and Drug metabolism - Introduction, metabolic routes, and models of drug administration
References	Fundamentals of Medicinal Chemistry, by Gareth Thomas, 2003, edition 1 Foye's Principles of Medicinal Chemistry, 8th edition, 2019 Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
Course Objective	The course focuses on the discovery, development, identification, and interpretation of the mode of action of biologically active compounds at the molecular level.
Justification:	Education and training of medicinal chemistry is highly demanding in the field of drug related industries.