M.Sc. PROGRAMME IN APPLIED CHEMISTRY

(Effective from Session 2025-26)

(Batch: 2025-2027)

SAMBALPUR UNIVERSITY

JYOTI-VIHAR, BURLA, SAMBALPUR, ODISHA-768019

SAMBALPUR UNIVERSITY

SEMESTER-WISE COURSE STRUCTURE FOR THE TWO YEARS P.G PROGRAMME IN UNIVERSITY P.G DEPARTMENT AND COLLEGES UNDER SAMBALPUR UNIVERSITY

TO BE EFFECTIVE FROM 2025-2026
BATCH: 2025-27
(Ref: letter No: 4873/Acd.-I Dated 21.08.2023)

For (Science/ Humanities/Social Sciences/ Commerce)				
Semester	**Core Course Credit**	**Additional Course**	**Additional Course Credit**	**Total Credit**
First	20	**AECC I**: Environmental Studies and Disaster management	2	22
Second	20	Inter Dept. Course (IDC) or open elective	3	23
Third	20	**AECC II**: Entrepreneurship Development	2	22
Fourth (including project of 4 credit)	20	MOOCs one paper	3	23
TOTAL	**80**		**10**	**90**
	Total credit for 2 years course = 90 Credits			
	Furthermore, following non - credit course will be taken by the students			
1. Yuva Sanskar		2. N.C.C/N.S. S/Sports/Performing Arts/Yoga (Of which one has to be opted)		

Semester Syllabus for M. Sc. in Applied Chemistry

w.e.f. 2025-26 Academic Year

FIRST SEMESTER			
Course No	**Course Title**	**Credit**	**Mark**
ACH-411	INORGANIC CHEMISTRY-I	04	100
ACH-412	ORGANIC CHEMISTRY-I	04	100
ACH-413	PHYSICAL CHEMISTRY-I	04	100
ACH-414	INSTRUMENTAL METHODS OF ANALYSIS	04	100
ACH-415	INORGANIC CHEMISTRY PRACTICAL	02	50
ACH-416	PHYSICAL CHEMISTRYPRACTICAL	02	50
	Total	**20**	**500**
In addition to this student(s) has to take either Environmental Studies or Disaster Management of 2 credit. The detail course will be available in the University website.			
SECOND SEMESTER			
Course No	**Course Title**	**Credit**	**Mark**
ACH-421	INORGANIC CHEMISTRY-II	04	100
ACH-422	ORGANIC CHEMISTRY-II	04	100
ACH-423	PHYSICAL CHEMISTRY-II	04	100
ACH-424	ATOMIC &MOLECULAR SPECTROSCOPY	04	100
ACH-425	ORGANIC CHEMISTRYPRACTICAL	02	50
ACH-426	ANALYTICAL CHEMISTRYPRACTICAL	02	50
	Total	**20**	**500**

1. ***In addition to this student(s) has to take one Inter Departmental Course of 3 credit offered by other departments. The detail course will be available in the University website.***
2. ***Also, the student has to opt for one MOOCS course of 03 credit through Swayam, NPTEL etc platform.***

THIRD SEMESTER			
Course No	**Course Title**	**Credit**	**Mark**
ACH-511	INDUSTRIAL POLLUTION & ITS MANAGEMENT	04	100
ACH-512	INDUSTRIAL PROCESSES	04	100
ACH-513	ANALYTICAL TECHNIQUES IN ORGANIC CHEMISTRY	04	100
ACH-514	PROJECT	04	100
ACH-515	INDUSTRIAL CHEMISTRYPRACTICAL	02	50
ACH-516	SEMINAR	02	50
	Total	**20**	**500**
In addition to this student(s) has to takeEntrepreneurship Development Program Course of 2 credit. The detail course will be available in the University website.			
FOURTH SEMESTER			
Course No	**Course Title**	**Credit**	**Mark**
ACH-521	ENERGY & MATERIAL BALANCE AND NANOMATERIALS	04	100
ACH-522	ADVANCED ANALYTICAL CHEMISTRY	04	100
ACH-523	MEDICINAL CHEMISTRY	04	100
ACH-524	SURFACTANTS AND DETERGENTS	04	100
ACH-525	COMPUTATIONAL CHEMISTRY PRACTICAL	02	50
ACH-526	COMPREHENSIVE VIVA	02	50
	Total	**20**	**500**

In addition to this the student has to take YuvaSanskar and to give preference for either NCC or NSS course.

FIRST SEMESTER

CH-411	**INORGANIC CHEMISTRY-I**	**4 credits**
UNIT-I:	**Basic Concepts of Symmetry and Group Theory**	
	Symmetry operation, symmetry element, classification of symmetry elements, definition of group, subgroup, cyclic groups, molecular point groups, group multiplication table, group generators, symmetry of platonic solids, conjugacy relation and classes, matrix representation of symmetry elements, character of a representation, reducible and irreducible representation, properties of irreducible representation.	
UNIT-II:	**Group Theory and Spectroscopy**	
	Character table (explanation and significance), construction of character tables for C_{2v}, C_{3v}, C_{4v}, C_{2h}, D_{2d} and D_4 point groups, direct product, standard reduction formula, applications of group theoretical methods for selection rules in: infrared spectroscopy, Raman spectroscopy and electronic spectroscopy.	
UNIT-III:	**Theories of Metal-Ligand Bonding**	
	Basic concepts of crystal field theory (CFT), molecular orbital theory (MOT): classification of metal valence orbitals into sigma symmetry, ligand group orbitals (LGOs) of sigma symmetry, LGOs of pi symmetry, molecular orbital energy level diagrams for octahedral and tetrahedral complexes, concept of ligand field theory (LFT).	
UNIT-IV:	**Term Diagram, Electronic Spectral and Magnetic Properties of Metal Complexes**	
	Concept of term symbols, derivation of term symbol for pn and dn configurations, Orgel diagram for dn configurations, Significance of Tanabe-Sugano diagram. Electronic spectra of metal complexes, selection rules, relaxation in selection rules, evaluation of Dq, B and beta(β) parameters for the complex with T1 ground state and A2 ground state, spectrochemical series and nephlelauxetic series, charge transfer spectra. Concept of magnetic properties of metal complexes.	
TEXT BOOKS:	1. *Chemical Applications of Group Theory by F. A. Cotton, Wiley India (P) Ltd., 3rd edn, 2009, New Delhi.* 2. *Symmetry and Spectroscopy of Molecules by K. V. Ready, New Age International Ltd. 2nd edn, 2009, New Delhi.* 3. *Symmetry and Group Theory in Chemistry by R. Ameta, New Age International Ltd., 1st edn, 2013, New Delhi.* 4. *Solid State Chemistry by D. K. Chakravarty, New Age International Limited, 1996, New Delhi.* 5. *Advanced Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley India (P) Ltd., New Delhi, 6th edition, 1999.* 6. *Fundamental concepts of Inorganic Chemistry (vol-5, and vol-6) by Asim K. Das and Mahua Das, CBS publishers and distributors, 2nd Edition,2019.*	
REFERENCE BOOK	1. *Inorganic Chemistry by G. L. Miessler and D. A. Tarr, Pearson Education, 3rd edn, 2004.* 2. *Inorganic Chemistry (Principles of Structure and Reactivity) by James E. Huheey, Ellen A. Keiter,Richard L. Keiter and Okhil K.Medhi Pearson Education, 4th edn, 2006.*	
ACH-412	**ORGANIC CHEMISTRY I**	**4 credits**
UNIT-I:	**Aromaticity and Electronic Effects**	
	Delocalized chemical bonding, Conjugation, Cross conjugation, Electronic effect, Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule, Alternant and non-alternant hydrocarbons, Energy levels in odd and even-alternant hydrocarbons, energy levels of π-molecular orbitals, Aromaticity of annulenes and hetero annulenes, Anti-aromaticity, Homo-aromaticity. Classification of reactions and mechanisms, Kinetic and thermodynamic control reactions, Hammond's postulate, Transition states and intermediates in Potential energy diagrams,The Hammett equation and linear free energy relationship, Substituent and reaction constants, Hard and soft acids and bases. Effect of structure on the strengths of acids and bases.	
UNIT-II:	**Aliphatic Substitution Reactions**	
	Nuceleophilic substitution – S_N2, $S_N1$and SET mechanisms. Neighboring group participation by σ and π-bonds, anchimeric assistance. Carbocation rearrangements, Nucleophilic substitution at an aliphatic trigonal, allylic and a vinylic carbon.	

	Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile, regioselectivity. Electrophilic substitution reactions – S_E1, S_E2 and S_Ei mechanisms, Effect of substrate, leaving group and solvent, Reactions (hydrogen exchange, migration of double bonds, keto-enol tautomerism, halogenation, aliphatic diazonium coupling, Stork-enamine reaction).
UNIT-III:	**Aromatic Substitution Reactions**
	Aromatic electrophilic substitution reactions – The arenium ion mechanism. Orientation and reactivity. Energy profile diagrams. Structure reactivity relationship in mono-substituted benzene, Quantitative treatment of reactivity in substrates and electrophiles. orientation in benzene and higher order rings with one or more than one substituent, Diazonium coupling, Vilsmeir - Haack reaction, Gatterman reaction, Gatterman-Koch reaction, Hoesch reaction Pechmann reaction. Aromatic Nucleophilic Substitution – ArS_N1, ArS_N2, benzyne, Effect of substrates, leaving groups, and attacking nucleophile, Reactions: Nucleophilic displacement in areno-diazonium salts by different nucleophiles, Goldberg reaction, Schiemann reaction ,Chichibabin reaction. Free radical Substitution: Intermediates, Reaction at sp^2 carbon, Reactivity in aliphatic, at bridge head position and in aromatic substrates.
UNIT-IV:	**General Stereochemistry**
	Chirality, Fischer projection and R and S notations, Threo and erythro nomenclature, E and Z nomenclature, Optical isomerism in biphenyls and allenes, Concept of Prostereoisomerism and Asymmetric synthesis, Conformation of a few acyclic molecules (alkanes, haloalkanes), Conformation of cyclic systems having one and two sp2 carbon atoms.
TEXT BOOKS:	1. *Organic Chemistry (Second Edition), by J. Clayden, N. Greeves, S. Warren.* 2. *Organic Reactions and Their Mechanisms by P S Kalsi, New Age International Private Limited; Fifth edition, 2020* 3. *Organic Reaction Mechanisms by Raj K. Bansal, New Age International Private Limited, 2012* 4. *Mechanism and Theory in Organic Chemistry by Lowry and Richardson (Harper Row Publishers, New York)* 5. *A Guidebook to Mechanism in Organic Chemistry by Peter Sykes* 6. *Jonathan Clayden, Nick Greeves, and Stuart Warren. "Organic Chemistry," Oxford University Press, 2014.* 7. *D. Nasipuri, Stereochemistry of Organic Compounds Principles and Applications, New Age International Publishers, 3rd Edition, 2011* 8. *Stereochemistry: Conformation and Mechanism by P.S. Kalsi New Age Publishers; Tenth Edition, 2019*
REFERENCE BOOKS:	1. *Advanced Organic Chemistry: Reaction Mechanism and Structure by Jerry March (Wiley Eastern Limited)* 2. *W. Carruthares, Iain coldham, Modern Methods of Organic Synthesis South Asia Edition, Cambridge University Press, Fourth Edition, 2015.* 3. *F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.* 4. *Stereochemistry of Organic Compounds by Ernest L. Eliel Wiley; 1st Edition, 2008*
ACH-413	**PHYSICAL CHEMISTRY I** **4 credits**
UNIT-I	***Chemical Kinetics & Fast Reaction***
	Theories of reaction rates, Collision theory, Transition state theory, Arrhenius equation and the activated complex theory, Reaction between ions, Salt effect, Steady-State Kinetics, Kinetic and Thermodynamic concept of Reactions, Treatment of unimolecular reaction (Lindeman-Hinshelwood and Rice-Ramspeger-Kassel-Marcus (RRKM) theories), Dynamic chain (H_2 + Br_2 reaction, pyrolysis of CH_3CHO, Decomposition of ethane). Study of Fast reactions by relaxation, Stopped flow and Flash photolysis methods.
UNIT-II	***Polymer Chemistry***
	Polymer-definition, Classification of polymer, Polymer structure, Number average and molecular weight average, Step growth & chain growth polymerization, Kinetics of

	polymerization, Stereochemistry of polymerization.	
UNIT-III	***Adsorption & Catalysis***	
	Adsorption, types of adsorptions, Gibbs adsorption isotherm, Freundlich's adsorption isotherm, Langmuir's adsorption isotherm and its limitations, BET adsorption isotherm and its applications, Heat of adsorption, estimation of surface areas of solids from solution adsorption studies, Enzyme Catalysis & Heterogeneous Catalysis.	
Unit-IV	***Phase Rule***	
	Concept of Equilibrium between phases, Derivation of phase rule, Ideal Solution, Liver Rule, Brief concept on one and two component system, Application of phase rule to three component systems of both solids and liquids.	
TEXT BOOKS:	1. *Chemical Kinetics by K.J. Laidler, Pearson; 3rd edition (1997)* 2. *Textbook of Physical Chemistry by K L Kapoor, McGraw Hill (2014)* 3. *Principles of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publishing Co, 47th Edition (2016)* 4. *Polymer Science by Gowariker, Viswanathan & Sreedhar*	
REFERENCE BOOKS:	1. *Advanced Physical Chemistry by D.N. Bajpai, S. Chand; 2nd edition (1992)* 2. *Atkins' Physical Chemistry by P. W. Atkins and Julio de Paula, , Oxford; 10th Edition (2014)* 3. *Reaction Kinetics by Pilling &Seakins* 4. *Physical Chemistry Through Problems by Dogra & Dogra*	
CH -414	**INSTRUMENTAL METHODS OF ANALYSIS**	**4 credits**
UNIT-I	**Atomic Absorption and Flame Emission Spectroscopy**	
	Basic Principle of atomic absorption spectroscopy (AAS), instrumentation, atomization techniques, application of AAS, sensitivity of instruments, strengths and limitations of atomic absorption spectroscopy. Basic principle flame emission spectroscopy (FES), instrumentation, application of FES, limitations in FES.	
UNIT-II	**Electroanalytical Method**	
	Polarography: principle, instrumentation, Ilkovic equation, Significance of half wave potential, application of polarography. Cyclic voltammetry: principle, instrumentation, and its application, ion selective electrodes.	
UNIT-III	**Thermoanalytical Methods**	
	Thermogravimetric analysis (TGA): Principle, instrumentation, factors affecting TGA curve, derivative thermogravimetric analysis (DTGA) and application of thermogravimetric analysis, differential thermal Analysis (DTA), instrumentation of DTA and application of DTA, simultaneous study of TGA, DTA with examples. differential scanning calorimetry (DSC) and thermometric titration.	
UNIT-IV	**Chromatography**	
	Principle and applications of thin layer chromatography (TLC), column chromatography (LC), gas chromatography (GC), high pressure column chromatography (HPLC).	
TEXT BOOKS:	1. *Analytical Chemistry (Theory and Practice) by U.N. Dash, Sultan Chand & Sons Pvt. Ltd., New Delhi, 2013.* 2. *Basic concept of Analytical Chemistry by S. M. Khopkar, New Age International (P) Ltd. Publishers, 3rd Edition, 2008.* 3. *Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand, Himalaya Publishing House, 5th Edition,2014.*	
REFERENCE BOOKS	1. *Quantitative Analysis by Vogel, Pearson Education Ltd., New Delhi, 6th edition, 2009.* 2. *Instrumental Method of Analysis by H. Willard, L. Merritt, J. Dean & F. Settle, CBS publisher and distributors Pvt. Ltd., 7th edition, 2004.*	
ACH -415	**INORGANIC CHEMISTRY PRACTICAL**	**2 credits**
	1. Inorganic salt mixture analysis Inorganic salt mixture analysis containing not more than four radicals. The mixture will include rare earth metal anions like Tungstate, Vanadate and Molybdate. Insoluble matters and other interfering radicals will also be included. Organic radicals are excluded 2. Estimation metal ions via volumetric analysis a) Estimation of Ca and Mg ions in a given a sample of cement by EDTA	

	method. b) Estimation of Cu ion in a given a sample of brass by iodometry method.	
BOOKS:	*1. Vogel's Qualitative Inorganic Analysis, 7th edition; Revised by G. Svehla.* *2. Vogel's Text Book of Quantitative Chemical Analysis, 5th Revised by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denny.* *Advanced Practical Inorganic Chemistry, 22nd edition; By Gurdeep Raj*	
CH -416	**PHYSICAL CHEMISTRY PRACTICAL**	**2 credits**
	1. Determination of ionization constants of weak acids and verification of Oswald's Dilution law. 2. Conductometric titration of Strong/Weak acid with Stron/Weak base 3. Conductometric titration of a mixture of HCl+CH_3COOH with NaOH 4. Potentiometric titration of strong acid with strong base. 5. Verification of Beer's Lambert Law and unknown concentration determination. 6. Verification of additivity rule spectrophotometrically. 7. Determination of temperature coefficient and energy of activation of hydrolysis of ethyl acetate. 8. To study the complex formation between ammonia and Cu^{+2}. 9. Determination of unknown dextrose solution by polarimetry 10. Study of inversion of cane sugar in acid medium by polarimetry.	
BOOK:	*1. Practical Physical Chemistry by B. Viswanathan & P. S. Raghavan, Viva Books* *2. Experimental Physical Chemistry by R.C. Das&B. Behera, McGraw-Hill Education*	

SECOND SEMESTER

ACH -421	**INORGANIC CHEMISTRY-II**	**4 credits**
UNIT-I	**Complexes of Carbon Monoxide and its Analogs**	
	Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important synthesis and reactions of metal carbonyls, carbonylate anions and carbonylate hydride, carbonyl halides; preparation, bonding and important reactions of transition metal complexes with isocyanide, cyanide, dinitrogen, carbon disulphide and nitrogen monoxides; chemistry of carbenes and carbynes.	
UNIT-II	**Metal Cluster and Polyacids**	
	Concept of metal cluster, bonding in metal clusters, metal carbonyl type clusters, anionic and hydride clusters, method of synthesis, super large cluster, electron counting in medium size cluster (Wade's rule, capping rule), isolobal relationship, clusters of Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt metals and their synthesis and reactions, Catalysis by metal cluster. Polyacids**:** definition, classification, polymerization of chromate, isopoly acids and anions, synthesis of isopoly acids, structures of isopolymolybdates, isopolytungstates and isopolyvanadates, heteropoly acids of W and Mo. Applications of isopoly and heteropoly compounds.	
UNIT-III	**Biomolecular Storage and Transportation of ions**	
	Lipids, lipid bilayer, biological membranes, Ramachandran's plot, biologically important metal ions (Na, K, Mg, Ca, Cu, Fe, Zn, Co and Mo) and their functions, passive and active transport processes, Na^+/K^+ pump, calcium pump, ionophores, storage and transport of iron, copper and zinc, siderophores, ferritin and transferrin in regard to iron-storage and transportation. Chemistry of porphyrin, iron porphyrins (heme proteins): hemoglobin (Hb), myoglobin (Mb) and their behavior as oxygen carrier, O_2 affinity, cooperativity and Bohr's effect, heme protein as electron carrier with particular reference to cytochrome-c and cytochrome-450, and cytochrome oxidase. Catalases and peroxidases. non-heme oxygen uptake protein (hemerythrin and hemocyanin). Magnesium porphyrins (Chlorophyll): Photosynthesis, the light and dark reaction (Calvin cycle). Non-heme iron-sulphur protein as electron carrier, rubredoxins and ferredoxins.	
UNIT-IV	**Biomolecular Catalysis**	
	Basic concepts of amino acids, peptides and proteins, structures of proteins, preliminary idea about enzyme, cofactor, co-enzyme, apoenzyme, prosthetic group, metal-activated enzyme and metalloenzyme. biological significance and mechanistic aspects of carboxypeptidase, carbonic anhydrase, blue-oxidases, non-blue oxidases, superoxide dismutase, structure and biological functions of molybdenum nitrogenase.	
TEXT BOOKS:	1. *Advance Inorganic Chemistry by F.A. Cotton, G. Wilkinson & C. Murillo, Wiley Publication, 6th edition, 1999.* 2. *Inorganic Chemistry (Principles of Structure and Reactivity) by James E. Huheey, Ellen A. Keiter, Richard L. Keiter and Okhil K. Medhi, Pearson Education, 4th edn, 2006.* 3. *Modern Aspect of Inorganic Chemistry by Emelius and Sharpe, Routledge & Kegan Paul PLC, England, 4th revised edition, 1978.* 4. *Bio-Inorganic Chemistry by Asim K Das.* 5. *Bio-Inorganic Chemistry by E. Ochia.* 6. *Bioorganic, BioInorganic and Supramolecular Chemistry by P. S. Kalsi and J. P. Kalsi.* 7. *Inorganic Chemistry (4thEdn) by Huheey, Keiter, Keiter and Medhi.* 8. *Bioinorganic and Suparmolecular Chemistry by A. Bhagi and G. R. Chatwal..*	
REFERENCE BOOKS	1. *Inorganic Chemistry by G. L. Miessler and D. A. Tarr, Pearson Education, 3rd edn, 2008.* 2. *Comprehensive Coordination Chemistry, by Wilkinson, Gillarsand, Pergamon Press, 1989.*	
ACH-422	**ORGANIC CHEMISTRY II**	**4 credits**
UNIT-I	**Addition Reactions**	

	Addition to C=C multiple bonds – Electrophilic, Nucleophilic and Free radical. Reactions: Hydroboration, Michael reaction, Sharpless Asymmetric epoxidation. Addition to carbon-heteroatom multiple bonds: Mechanism and reactivity, Reactions: $LiAlH_4$ reduction of carbonyl compounds, acids, esters, nitriles, addition of Grignard reagents to carbonyl compounds, Reformatsky reaction, Aldol condensation, Knoevenagel condensation, Perkin reaction, Mannich reaction, Wittig reaction, Stobbe reactions, Tollens reaction, Benzoin condensation.
UNIT-II	**Elimination Reactions**
	E_1, E_2, E_1CB and E_2CB mechanisms, Orientation, Effect of substrate, base, leaving group and medium, Orientation of double bond, Sayetzeff and Hoffman rules, Pyrolytic elimination reaction, Oxidative elimination (oxidaton of alcohol by chromium, Moffatt oxidation). Reactions: Cleavage of quaternary ammonium hydroxides, Chugaev reaction, Shapiro reaction.
UNIT-III	**Mechanistic Considerations**
	Nature of migration, migratory aptitude, memory effects. Rearrangements: Wagner-Meerwein, Favorskii, Fries, Carbene intermediate, Arndt-Eistert synthesis, Neber, Nitrene intermediates (Beckmann, Hofmann, Schmidt, Lossen, Curtius), Baeyer-Villiger, Shapiro reaction, Von-Richter, Sommelet-Hauser rearrangement.
UNIT-IV	**Dynamic Stereochemistry**
	Conformation and reactivity, Selection of substrates, Quantitative correlation between conformation and reactivity, (Weinstein-Eliel equations and Curtin-Hammett principles), Conformational effects on stability and reactivity in acyclic compounds (ionic elimination, intramolecular rearrangements) and in cyclic systems, (Nucleophilic substitution reaction at ring carbon, Formation and Cleavage of epoxide rings, Addition reactions to double bonds, Elimination reactions). Stereospecific and stereoselective reactions.
TEXT BOOKS:	1. *Organic Chemistry (Second Edition), by J. Clayden, N. Greeves, S. Warren.* 2. *Organic Reactions and Their Mechanisms by P S Kalsi, New Age International Private Limited; Fifth edition, 2020* 3. *Organic Reaction Mechanisms by Raj K. Bansal, New Age International Private Limited, 2012* 4. *Mechanism and Theory in Organic Chemistry by Lowry and Richardson (Harper Row Publishers, New York)* 5. *A Guidebook to Mechanism in Organic Chemistry by Peter Sykes* 6. *Jonathan Clayden, Nick Greeves, and Stuart Warren. "Organic Chemistry," Oxford University Press, 2014.* 7. *D. Nasipuri, Stereochemistry of Organic Compounds Principles and Applications, New Age International Publishers, 3rd Edition, 2011* 8. *Stereochemistry: Conformation and Mechanism by P.S. Kalsi New Age Publishers; Tenth Edition, 2019*
REFERENCE BOOKS:	1. *Advanced Organic Chemistry: Reaction Mechanism and Structure by Jerry March (Wiley Eastern Limited)* 2. *W. Carruthares, Iain coldham, Modern Methods of Organic Synthesis South Asia Edition, Cambridge University Press, Fourth Edition, 2015.* 3. *F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.* 4. *Stereochemistry of Organic Compounds by Ernest L. Eliel Wiley; 1st Edition, 2008*
ACH-423	**PHYSICAL CHEMISTRY II** **4 credits**
UNIT-I	***Classical Thermodynamics***
	Brief resume of the concepts of laws of thermodynamics, Free energy, chemical potential and entropy, Third law of thermodynamics and determination of entropy, Entropy and probability, Boltzmann-Planck equation, Partial molar properties (partial free energy, molar volume and molar heat content), Their significance and determination. Concept of fugacity and its determination.
UNIT-II	***Classical and Quantum Statistical Mechanics***
	Concept of probability, Starling approximations, Most probable distribution, System, Phase Space, μ-Space, 1-Space, Liouville's Theorem, Statistical Equilibrium, Brief Concepts on Ensembles, Canonical, Grand Canonical and Micro-canonical ensembles.

	Bose-Einstein statistics, Fermi-Dirac statistics and Maxwell-Boltzmann statistics	
UNIT-III	***Partition Functions & Statistical Thermodynamic Properties of Solids***	
	Significance of partition function, Calculation of thermodynamic properties and equilibrium constant in terms of partition functions, Evaluation of transnational, vibrational and rotational partition function for monoatomic and polyatomic ideal gases, electronic partition function. Some thermal characteristics of crystalline solids, Classical treatment of solids, Einstein Model, Debye Modification, Limitation and modification of Debye theory.	
UNIT-IV	**Computer Application in Chemistry**	
	Basic structure of a computer: The CPU, the I/O devices, the internal memory, commonly used secondary storage media. Data representation: Overview of binary, octal and hexadecimal number system. The software: Concept of low level and high-level languages, Compiler interpreter, editor, operating system concepts, salient features of Windows and LINUX operating systems. Algorithm, Flowchart, Decision-table, elements of high-level programming languages. Application of numerical methods to chemical problems.	
TEXT BOOKS:	1. *Text Book of Physical Chemistry by K.L. Kapoor* 2. *Principles of Physical Chemistry by Puri, Sharma &Pathania* 3. *Chemical Thermodynamics by Rastogi & Mishra* 4. *Thermodynamics for Chemists by S. Glasstone* 5. *Molecular Thermodynamics by McQuarrir& Simon* 6. *Statistical Thermodynamics by M. C. Gupta* 7. *Computational Chemistry by A.C. Norris*	
REFERENCE BOOKS:	1. *Advanced Physical Chemistry by D.N. Bajpai, S. Chand; 2nd edition (1992)* 2. *Atkins' Physical Chemistry by P. W. Atkins and Julio de Paula, , Oxford; 10th Edition (2014)* 3. *Physical Chemistry Through Problems by Dogra & Dogra* 4.	
ACH-424	**ATOMIC &MOLECULAR SPECTROSCOPY**	**4 credits**
UNIT-I	***Atomic Spectroscopy***	
	The electromagnetic spectrum, A general discussion on various molecular excitation processes, Spectra of hydrogen and hydrogen like atoms, alkali metals spectra, L-S coupling, Term symbols, Space quantisation, Zeeman effect, Stark effect, Paschen-Back effect.	
UNIT-II	***Vibrational & Rotational Spectroscopy & Raman Spectroscopy***	
	Molecular Spectra of Diatomic Gases, Classification of molecules, Rotational Spectra, Vibrational Spectra, Vibrational-Rotational Spectra, P, Q and R Branches. Theory of Raman spectra, Rotational Raman spectra, Vibrational Raman spectra, Rotational-Vibrational Raman spectra, comparison with IR spectra.	
UNIT-III	***Electron Spin Resonance Spectroscopy***	
	Theory, instrumentation, g-values, hyperfine splitting, ESR spectra of systems with more than one unpaired electron, double resonance, ENDOR and ELDOR techniques.	
UNIT-IV	***Photoelectron &Mossbauer Spectroscopy***	
	Principles of Photoelectron spectroscopy, ultraviolet photoelectron spectra and their interpretation Principles of Mossbauer spectroscopy, Experimental methods, Theoretical aspects, Quadrupole splitting, Magnetic hyperfine interaction.	
TEXT BOOKS:	1. *Fundamentals of Molecular Spectroscopy by C.N. Banwell* 2. *Fundamentals of Molecular Spectroscopy by G.M. Barrow* 3. *Molecular Spectroscopy, P.S. Sindhu*	
REFERENCE BOOKS:	1. *Advanced Physical Chemistry by D.N. Bajpai, S. Chand; 2nd edition (1992)* 2. *Atkins' Physical Chemistry by P. W. Atkins and Julio de Paula, , Oxford; 10th Edition (2014)* 3. *Physical Chemistry Through Problems by Dogra & Dogra* 4. *Spectroscopy Vol. I & II by Walker & Straw*	
ACH-425	**ORGANIC CHEMISTRY PRACTICAL**	**2 credits**
	1. Isolation and identification of multi-functional compounds in a mixture of two organic compounds.	

	2. Preparation of; a) Benzoin, benzil and benzillic acid from benzaldehyde. b) p-idotoluene from p-toluidene. c) Ethyl acetoacetate from ethyl acetate. 3. Estimation of; a) Nitrogen by Kjeldahl method. b) keto group by gravimetric method.	
BOOK:	*Advanced Practical Organic Chemistry, 3/e by N K Vishnoi*	
ACH-426	**ANALYTICAL CHEMISTRY PRACTICAL**	**2 credits**
	1. Determine the pK value of an acid-base indicator. 2. To estimate metal ions by spectrophotometric titration. 3. To determine the pH of a given solution by spectrphotometrically. 4. Adsorption of CH_3COOH on activated charcoal and verification of Freundlich's &Langumir's adsorption isotherm. 5. Simultaneous estimation of Mn and Cr in a solution of $KMnO_4$ and $K_2Cr_2O_7$. 6. Determination of hydrolysis constant of aniline hydrochloride. 7. Determination of ionisation constants of multibasic acid potentiometrically. 8. Determination of association constants of CH_3COOH by distribution method between water and toluene. 9. To study the rate of acid catalysed iodination of acetone in presence of excess acid and acetone. 10. To study the stability constant of a metal complex. 11. Estimation of Fe ion in a solution of Mhor's salt.	
BOOK:	1. *Practical Physical Chemistry by B. Viswanathan & P. S. Raghavan, Viva Books* 2. *Experimental Physical Chemistry by R.C. Das&B. Behera, McGraw-Hill Education*	

THIRD SEMESTER

ACH -511	**INDUSTRIAL POLLUTION & ITS MANAGEMENT**	**4 Credits**
UNIT-I	***Basics of Industrial Pollution***	
	Concept and definition of Industrial pollution, Environment and its classification, Factors influencing environment, Components of Environment; Bio-geochemical cycles; Hydrological cycle, Gaseous cycles (Oxygen cycle, CO_2 cycle, Nitrogen cycle), Sedimentary cycles (Sulfur cycle, Phosphorous cycle); Effects of Industries on the environment; Environmental degradation.	
UNIT-II	***Industrial Air Pollution***	
	History of major industrial air pollution episodes. Types and classification of Industrial air pollutants. Characterization of gaseous effluents of major industries (thermal power plant, steel, cement, aluminum, paper, fertilizer) and their health effects. Permissible limit and ambient air quality, Methods for control of gaseous air pollutants (Combustion, Absorption and Adsorption). Methods for control of particulate air pollutants (Mechanical device, Filtration, Dry scrubber, Electrostatic precipitator).	
UNIT-III	***Industrial Water Pollution***	
	History of major industrial water pollution episodes, Classification and types of Industrial water pollutants, Characterization of some liquid effluents of major polluting industries (Paper Mills, Sugar industry, Iron and steel and Textile) and their health effects, Water quality standard : Drinking water quality standard, Irrigation water standard and effluent standard, methods of treatment of industrial waste water: Preliminary treatment, primary treatment, (Sedimentation, equalization and neutralization etc.), secondary treatment (Activated sludge technique and Trickling filter) tertiary treatment methods for waste water treatment (Evaporation, Ion exchange, Adsorption, Electrodialysis, Electrolytic recovery, reverse osmosis).	
UNIT-IV	***Industrial Solid Wastes***	
	Classifications and types of Industrial solid wastes, Generation, disposal and management of industrial solid wastes with special reference to fly ash, red mud, heavy metals (Mercury, Lead, Arsenic, Cadmium), other organic solid wastes and radio-active wastes. Industrial sources of noise, Loudness on Decibel scale, noise levels in decibel scale, effect of noise on human health, prevention and control of industrial noise pollution.	
TEXT BOOKS:	1. *Industrial Pollution and Management by Arvind Kumar, APH Publishing Corporation, New Delhi.* 2. *Industrial Pollution and its Management by P.C. Trivedi, Avishkar Publishers & Distributors, Jaipur* 3. *Pollution Control in Process Industries by S.P. Mahajan, Tata McGraw Hill Publishing Company, New Delhi* 4. *Environmental Engineering by G Kiely, Tata McGraw Hill Publishing, Company, New Delhi.*	
REFERENCE BOOKS	1. *Environmental Pollution and Control, 4th ed. by J. Jeffrey Peirce, P. AarneVesilind, RuthF. Weiner, Elsevier Publication*	
ACH-512	**INDUSTRIAL PROCESSES**	**4 credits**
UNIT-I	***Petroleum and Coal Based Chemicals***	
	Composition of petroleum, cracking processes, Commercial production of ethylene, acetylene, polymerization mechanisms, Addition, condensation, step growth, chain growth, method of polymerization, Distillation of coal.[10]	
UNIT-II	***Oil Based Industries & Surface-Active Agents***	
	Oils and fats: Solvent extraction of oils, hydrogenation of oil, use of oil in the manufacturing of soap, paints and varnishes. Classification of surface-active agents and manufacturing of detergents used for cleansing purpose.	
UNIT-III	***Fermentation Industries***	

	A general discussion on fermentation conditions, manufacturing of penicillin, Alcoholic beverages, ethanol from molasses and starchy material	
UNIT-IV	***Pesticides and Pharmaceutical Industries***	
	DDT manufacture, BHC manufacture, 2,4-D manufacture, parathion manufacture, pharmaceutical industry	
TEXT BOOKS:	1. *Outlines of Chemical Technology by M. Gopala Rao and Marshall Sittig, Affiliated East-West Press Pvt. Ltd.* 2. *Industrial Chemistry by B. K. Sharma*	
ACH-513	**Analytical Techniques in Organic Chemistry**	**4 credits**
UNIT-I	**Nuclear Magnetic Resonance**	
	Magnetic properties of nuclei, Theory of magnetic nuclear resonance with special reference to proton, Instrumentation, Chemical shift, Simple spin-spin interaction, Shielding effects, Diamagnetic anisotropy, NOE, ^{13}C, ^{15}N, ^{19}F, ^{31}P NMR (preliminary idea).	
UNIT-II	**Mass Spectrometry**	
	Introduction, Mass spectrum, Determination of molecular formulae, molecular ions, Parent peak, Base peak, Use of molecular fragmentation, McLafferty rearrangement, Mass spectra of some classes of compounds (hydrocarbons, alcohols, phenols, ketones, aldehydes, acids and esters)	
UNIT-III	**Spectroscopic Identification of Organic Compounds**	
	Problems involving identification of organic compounds using UV, IR, NMR and Mass spectroscopy.	
UNIT-IV	**Optical Rotatory Dispersion and Circular Dichroism**	
	Plane polarized and circularly polarized lights, Circular birefringence and circular dicroism, ORD, Cotton effect, Rotatory Dispersion of ketones, the Octant rule, Axial haloketone rule.	
TEXT BOOKS:	1. *Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James R. Vyvyan, Cengage Learning India Private Limited; 2015* 2. *R.M. Silverstein, G. C. Bassler, T. C. Morril, Spectrometric identification of Organic Compounds, John Wiley & Sons, Inc, 2010* 3. *D. Nasipuri, Stereochemistry of Organic Compounds Principles and Applications, New Age International Publishers, 3rd Edition, 2011* 4. *Spectroscopic Identification of Organic Compounds: Silverstein &Basselor, Wiley; 8th edition, 2014*	
REFERENCE BOOKS	1. *Spectroscopy of Organic Compounds, by P S Kalsi, New Age International, 2007* 2. *Basic ^{1}H- and ^{13}C NMR spectroscopy, by M. Balci, Elsevier, 2005*	
ACH-514	**PROJECT**	**4 credits**
	Each student shall carry out project work in industries/institutions. The findings of the project work should be submitted in the form of a dissertation for evaluation by a Board of Examiners.	
A**CH-515**	**INDUSTRIAL CHEMISTRY PRACTICAL**	**2 credits**
	1. Determination of percentage of purity of commercially available different N, P and K fertilizer. 2. Water analysis: (a) Residual chlorine in town supply water (b) Ammonia content of sewage water 3. Determination of acid value, saponification value and iodine value of different oils 4. Preparation of indigo from anthranilic acid. 5. Preparation of cinnamic acid from benzaldehyde. 6. Preparation from flavone from o-hydroxy acetophenone. 7. Estimation of sulfur in isothiouronium chloride prepared from thiourea. 8. Separation of components from a mixture by TLC and column chromatography.	
Books	*From various sources books and journals*	
ACH-516	**SEMINAR**	**2 credits**
	Each student has to present a seminar on published paper in the last two years.	

FOURTH SEMESTER

ACH -521	**ENERGY & MATERIAL BALANCE AND NANOMATERIALS**	**4 credits**
UNIT-I:	***Energy and Material Balance***	
	Energy and Thermo-Chemistry, Energy Balances, Heat Capacity of GaseousMixtures, Latent Heats, Enthalpy Changes During Phase Transfers Accompanied by Sensible Heat Changes, Enthalpy Changes accompanying Chemical Reactions. Material Balances Without Chemical Reactions: Process Flow-Sheet, Material Balances, Recycling Operations, Material Balances of Unsteady State Operations. Material Balances Involving Chemical Reactions, Definition of Terms, Electrochemical Reactions, Recycling, Parallel and Bypassing Operations, Metallurgical Applications	
UNIT-II:	**Semiconductors and Devices**	
	Conducting and semiconducting organic materials. Synthesis and characterizations of organic semiconductors, Conducting and semiconducting materials and insulator, Band gap engineering. Doping of semiconductors. Application of carbon-based materials. Applications in electronic devices.	
UNIT-III:	**Nanomaterials for Energy Conversion and Storage Materials**	
	Nanomaterials for Solar Energy Conversion Systems. Principles of photovoltaic energy conversion (PV), Structural characteristics and concepts. Types of photovoltics Cells, Physical concept of photovoltaic cells, Organic solar cells, Dye-Sensitized Solar Cells, Organic-Inorganic Hybrid solar cells. Device fabrication techniques and characterizations, Structure and features of ferroelectric materials, dielectric properties, piezo and inverse piezoelectric effects.	
UNIT-IV:	***Polymers and their Applications***	
	Stress-strain behavior, High temperature resistant organic/inorganic polymers, effect of chain flexibility and other steric factors, entropy and heat of fusion, glass transition temperature, relationship between Tm and Tg. Effect of molecular weight on polymer properties and their applications. Synthetic procedure commercial polymers (polycarbonate, polyurethane, polymethylmethacrylate, polyethyleneterpthalate, Nylon, polystyrene), Fire retarding and biomedical polymers	
TEXT BOOKS:	1. *Stochiometry by B I Bhatt and S. M. Vora (Tata McGraw Hill, New Delhi)* 2. *Semiconductor for Solar Cells by H J Moller, Artech House Inc, MA, USA, 1993.* 3. *Solis State Electronic Device by Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.* 4. *Organic Photovoltaics – Materials, Device Physics and Manufacturing Technologies, (eds. by C. Brabec, V. Dyakonov, U. Scherf), 2nd Ed., Wiley-VCH, Germany, 2014.* 5. *Text Book of Polymer Science by F.W. Billmeyer Jr, Wiley.* 6. *Polymer Science by V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.*	
REFERENCE BOOKS	1. *Solis state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.*	
ACH-522	**ADVANCED ANALYTICAL CHEMISTRY**	**4 credits**
UNIT-I:	***Reliability of Analytical Data***	
	Errors in chemical analysis, classification of errors, significant figures, precision andaccuracy, methods of expressing accuracy, absolute error and relative error, methodsof expressing precision, average deviation, standard deviation, confidence limits, median value, range, coefficient of variation. Sampling in analysis definition: Theory of sampling, technique of sampling, statistical criteria of good sampling and required size, stratified sampling, transition and storage samples.	
UNIT-II:	***Ultraviolet and Visible Spectrophotometry***	

	Introduction, nature of absorbing species, visual colorimetry, photo-electric cell andfilters, Photoelectric filter photometry, errors in photoelectric photometry,Spectrophotometry, working of spectrophotometer, simultaneous spectrophotometry,differential spectrophotometry, reflectance spectrophotometry, photometric titrations,composition of coloured complex Sandell's sensitivity, relative concentration and Ringbon's plot.	
UNIT-III	***Electron Microscopy***	
	Introduction to optics, Principles of image formation, Light microscopy techniques, Electron Microscopy (SEM and TEM), Instrumentation of SEM and TEM, Application of SEM and TEM, Limitations of electron microscopy	
UNIT-IV	***Analytical Applications of Organized Assemblies***	
	Basic concepts of organized assemblies, Application of micellar systems for UV-Visible/fluorescence spectroscopic detection of ions, micellar enhanced phosphorescence and fluorescence, micellar systems in liquid-liquid extraction, surfactant aggregates in flame and plasma atomic spectrometry, micellar systems in chromatography, recent developments in micellar chromatography, application of surfactants in gel electrophoresis.	
TEXT BOOKS	*1. Basic Principle of Analytical Chemistry by S.M. Khopkar* *2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogal.*	
REFERENCE BOOKS	*1. Physical Chemistry of Macromolecules by C. Tanford*	
ACH-523	**MEDICINAL CHEMISTRY**	**4 credits**
UNIT-I:	***Overview of drug action and Modern Drug Development Process***	
	Definition of drugs, types of pharmacological action of drugs, classification of drugs based on their origin, Drug action, Factors affects ADMET, Modern Drug Development process, Initial steps in drug discovery process, Screening of model organism, parameters involved in drug design physicochemical ionization, H-bonding, chelation.	
UNIT-II:	***Pharmacokinetics and Pharmacodynamics***	
	Introduction, Kinetics of ADME, Methods of assessing major physicochemical properties of compounds, Biochemistry of enzymes, Allosteric enzymes, Roles of enzymes in metabolism, Receptors, their types, location, isolation, transduction mechanism.	
UNIT-III:	***Strategies for Synthesis of Candidate Drug***	
	1. Target selection 2. Retro synthesis (the disconnection approach consecutive versus conversion synthesis including LHASA, strategic bond approach, strategic bond in ring approach, degradation of techniques in, synthetic design of venalflaxin, doxopicomine, clobutinol, nisoxetine, bropirimine.	
UNIT-IV:	***Drug and their Applications***	
	Chemotherapy of cancer: veincristine and vinblastine and taxol, drug related hormones insulin, vasopressin and oxitosin, prostaglandin, histamine, antiparkinosin agents antialzehimer agents, antirheumatics and antigout agents.	
TEXT BOOKS	*1. Introduction to the Principles of Drug Design by Smith and Williams.* *2. Principle of Biochemistry by A.L. Lehninger, D.L. Nelson & Michael M Cox.* *3. Organic Chemistry by J. Clayden, N. Greeves, S Warrens, P.Wothers.* *4. An Introduction to Medicinal Chemistry, Dr. Bijoy Kundu, Wiley, First Edition, 2020*	
REFERENCE BOOK	*1. Medicinal Chemistry by Alfred Burger.* *2. Strategy of Drug Design by Purcell.*	
ACH-524	**SURFACTANTS & DETERGENTS**	**4 credits**
UNIT-I	***Structural Aspects of Surfactants***	

	Surfactants, Classification(Anionic surfactants, Cationic head surfactant, Zwitterionic surfactants, Nonionic surfactant,Biosurfactants, Gemini surfactant, double tailed surfactant, Bolaform), Synthesis of Surfactant, Behaviour of Surfactants in aqueous and nonaqueous solution, Different types of interactions, Surface activity, Surface tension, Factors for organization of surfactants and types of organized assemblies, Hydrophobic interactions, electrostatic interactions, Critical micellar concentration (CMC), Factors affecting CMC, Methods of CMC determination. Aggregation number, Shape and Size of micelle.
UNIT-II	***Application of Surfactant***
	Spectroscopic investigation and analytical methods, determination of polarity of micelle, structures of micelle, Determination of aggregation number, Industrial Applications of surfactants, Beneficiation of minerals, micellar catalysis, Drug delivery, Wetting, Dispersion and foaming.
UNIT-III	***Structural Aspects of Detergents***
	Detergents, Principal groups of synthetic detergents, Anionic detergents, Cationic detergents, Non-ionic detergents, Amphoteric detergents, Industrial methods of preparation of Detergents, Concept of hard and soft water, Removal of hardness of water, Oil and fat, General idea of Suds regulators, builders, additives.
UNIT-IV	***Application of Detergents***
	Manufacture of Shampoos. theories of glyceride structure, Hydrolysis of glycerides, Use of oil in the manufacturing of soap, Principle of soap cleaning, Analysis of soaps as per BIS standards, use of enzymes in detergents, Catalytic hydrogenation of oil, Recovery of Nickel from hydrogenated oil product.
BOOKS:	*1. Industrial Chemistry by B. K. Sharma, 9thEdn.* *2. The Manufacture of Soaps other Detergents and Glycerin Edited by Edgar Woollatt.* *3. Synthetic Detergent Edited by Milwidsky.* *4. Bailey's Industrial Oil and Fat Products Vol-1 (4th Edition) Edited by Daniel Swern.* *5. Soaps & Detergent Edited by K.S. Parasuram.* *6. Surfactants and Interfacial Phenomenon by M.J. Rosen* ***7.** Catalysis in Micellar and Macromolecular Systems BY E.J. Fendler and J.H. Fendler*
ACH-525	**COMPUTATIONAL CHEMISTRY PRACTICAL** **2 credits**
	1. Use of Microsoft Excel: Balancing Chemical Equations, Bond Enthalpy of Hydrocarbons, Spectrophotometric Analysis, Curve Fitting 2. Use of Chemdraw: Design molecular 2-D geometry, Preparation of reaction scheme **3.** Execution of the Software to solve problems: Eigenvalues and Eigenvectors, Charge Density, Delocalization energy, Molecular geometry, Vibrational frequencies
ACH -526	**COMPREHENSIVE VIVA**
	Comprehensive viva-voce examination shall be conducted jointly by the external and internal Examiners. Short questions on the theoretical principles, experimental methodologies and instrumentations etc. of the different experiments included in the entire practical/project syllabus of semesters-I, -II, -III and -IV may be asked.