HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

M.Sc., CHEMISTRY

Curriculum and Syllabus
(Regulations 2018)

DEPARTMENT OF CHEMISTRY
School of Science and Humanities

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE, PADUR
M.Sc., (CHEMISTRY)

CURRICULUM 2018

SEMESTER – I

SN	Course Code	Course Category	Course Title	L	T	P	C	TCH
1.	CYA2701	CC	Chemical and Statistical Thermodynamics	3	1	0	4	4
2.	CYA2702	CC	Essentials of Organic Chemistry	3	1	0	4	4
3.	CYA2703	CC	Chemical Bonding and Molecular Geometry	3	1	0	4	4
4.	CYA2704	CC	Quantum Chemistry and Group Theory	3	1	0	4	4
5.	CYA2705	CC	Analytical Chemistry	3	0	0	3	3
Practical								
6.	CYA2731	CP	Physical Chemistry Practical	0	0	6	3	6
Total Credits for the Semester							**22**	**25**

SEMESTER – II

SN	Course Code	Course Category	Course Title	L	T	P	C	TCH
1.	CYA2711	CC	Chemical Kinetics and Catalysis	3	1	0	4	4
2.	CYA2712	CC	Organic Reactions	3	1	0	4	4
3.	CYA2713	CC	Inorganic Elements and Solid State Chemistry	3	1	0	4	4
4.	CYA2714	CC	Molecular Spectroscopy	3	0	0	3	3
5.	CYA2715	CC	Nuclear chemistry and Biomolecules	3	0	0	3	3
Practical								
6.	CYA2741	CP	Inorganic Chemistry Practical	0	0	6	3	6
Total Credits for the Semester							**21**	**24**

SEMESTER – III

SN	Course Code	Course Category	Course Title	L	T	P	C	TCH
1.	CYA2801	CC	Electrochemistry and Electrodics	3	1	0	4	4
2.	CYA2802	CC	Reagents and Organic Synthesis	3	1	0	4	4
3.	CYA2803	CC	Coordination and Organometallic Chemistry	3	1	0	4	4
4.	CYA2804	CC	Spectroscopy - Applications in Organic and Inorganic Chemistry	3	0	0	3	3
Practical								
5.	CYA2831	CP	Organic Chemistry Practical	0	0	6	3	6
6.	CYA2832	MP	Project Phase-I	0	0	3	1	3
Total Credits for the Semester							**19**	**24**

SEMESTER – IV

SN	Course Code	Course Category	Course Title	L	T	P	C	TCH
1.	CYA285*	CE	Group 1 – Core Elective I	3	0	0	3	3
2.	CYA286*	CE	Group 2 – Core Elective II	3	0	0	3	3
3.	CYA287*	AE	Group 3 – Allied Elective	2	0	0	2	2
Practical								
4.	CYA2841	SE	Seminar	0	0	0	1	0
5.	CYA2842	CM	Comprehensive Viva-voce	0	0	0	1	0
6.	CYA2843	FP	Project Phase-II	0	0	16	8	17
Total Credits for the Semester							**18**	**25**
TOTAL CREDITS FOR THE PROGRAM							**80**	

Abbreviations

CC - Core Course
CP - Core Practical
CE - Core Elective
CM - Comprehensive
AE - Allied Elective
SE - Seminar
MP - Mini Project
FP - Final Project
L - Lecture hours
T - Tutorial hours
P - Practical Hours
C - Credits offered
TCH - Total Contact Hours

ELECTIVE COURSES – SEMESTER IV

S.N.	Subject Code	SUBJECT NAME	L	T	P	C	TCH
GROUP 1 – Core Elective							
1.	CYA2851	Photochemistry	3	0	0	3	3
2.	CYA2852	Homogeneous & Heterogeneous Catalysis	3	0	0	3	3
3.	CYA2853	Organometallic Chemistry For Organic Synthesis	3	0	0	3	3
GROUP 2 – Core Elective							
4.	CYA2861	Synthetic Methodology In Organic Chemistry	3	0	0	3	3
5.	CYA2862	Heterocyclic Chemistry	3	0	0	3	3
6.	CYA2863	Polymer Chemistry	3	0	0	3	3
GROUP 3 – Allied Elective							
7.	CYA2871	Fertilizer Technology	2	0	0	2	2
8.	CYA2872	Pharmaceutical Chemistry	2	0	0	2	2
9.	CYA2873	Chemistry of Nanomaterials	2	0	0	2	2

SYLLABUS

COURSE TITLE	**CHEMICAL AND STATISTICAL THERMODYNAMICS**			CREDITS	4
Course Code	**CYA2701**	**Course Category**	**CC**	**L-T-P-S**	**3-1-0-0**
CIA	**40%**			**ESE**	**60%**
LEARNING LEVEL	**BTL-5**			**ASSESSMENT MODEL**	**TA**

	COURSE OUTCOMES	**PO**
1.	Able to understand and apply the Laws of thermodynamics in heat engine and other devices	1
2.	Able to apply Van't Hoff's isotherm, isochore -Gibb Helmholtz equation for the determination of spontaneous reaction.	1
3.	Able to calculate change in thermodynamic properties, equilibrium constants, partial molar quantities, chemical potential. Identify factors affecting equilibrium constant	2
4.	Able to calculate thermodynamic properties of ideal gases, real gases and solids using the principles and techniques of statistical thermodynamics.	2,3
5.	The students would have understood the chemistry of non-equilibrium thermo-dynamics, so that they can learn about entropy flow in open systems, and microscopic reversibility.	3,4,5

Prerequisites : Basic knowledge in thermodynamics

MODULE 1 – CHEMICAL THERMODYNAMICS (12L)

Ist Law of thermodynamics - isothermal, adiabatic and isobaric processes - internal energy and enthalpy-bond energies - Hess's law and Kirchoff's law - heat capacities - Joule Thomson effect. IInd law of thermodynamics -entropy, heat engine (Carnot cycle) and its efficiency -entropy and spontaneity of processes–MaxwellsRelations- IIIrd law of thermodynamics and entropy at absolute zero.

Suggested Reading: Terminologies of thermodynamics

MODULE 2 – CHEMICAL EQUILIBRIA (12L)

Helmholtz and Gibbs free energies - thermodynamic functions and properties - standard free energy of formation as a function of pressure and temperature equilibrium constant - Van't Hoff's isotherm and isochore - Gibbs Helmholtz equation criteria for spontaneity - Ellingham diagram- methods of free energy determination.

Suggested Reading: Helmholtz and Gibbs free energies and equilibrium constant

MODULE – 3 : APPLICATIONS OF THERMODYNAMICS (12L)

Partial molal quantities - Chemical potential - Fugacities of gases and their determination- activity and activity coefficients - Gibbs Duhem equation - Entropy and free energy of mixing - standard states of substances - osmotic pressure and its determination.

Suggested Reading: Chemical potential , Fugacities, activity coefficients

MODULE – 4 : STATISTICAL THERMODYNAMICS (12L)

Terminology of statistical thermodynamics - Maxwell Boltzmann distribution - thermodynamic properties in terms of partition functions. Heat capacity of solids - Debye and Einstein models. Thermodynamic functions for gaseous systems- translational, vibrational and rotational contributions to thermodynamic properties - Fermi Dirac and Bose Einstein statistics - Application of statistical thermodynamics - concepts to ortho para hydrogen - internal rotation - calculation of equilibrium constants.

Suggested Reading: Terminology of statistical thermodynamics

MODULE 5 – NON-EQUILIBRIUM THERMODYNAMICS (12L)

Steady state – conservation of energy and mass-entropy production and entropy flow in open system – fluxes and forces – transformation of properties of rates and affinity – microscopic reversibility and Onsager reciprocal relation am dots experimental verification.

Suggested Reading: principles of non-equilibrium thermodynamics

TEXT BOOKS

1.	Peter Atkins, Julio de Paula, Elements of Physical Chemistry, fourth edition, W.H. Freeman & Company, 2005
2.	G. M. Barrow, Physical Chemistry (V Edition), Tata McGraw Hill Education, 2007

REFERENCE BOOKS

1.	Puri Br, Sharma Lr, Madan S Pathania; Principles of Physical Chemistry, Vishal Publishing Co, 2008.
2.	S. Glasstone, Thermodynamics for chemists, Narahari Press, 2007.

E BOOKS

1.	Introductory Physical Chemistry b**y** David Ronis - McGill University **,** 2011
2.	Physical Chemistry in Brief b**y** J.P. Novak, S. Labik, I. Malijevska - Institute of Chemical Technology, Prague **,** 2005

MOOC

1.	https://www.my-mooc.com/en/mooc/introduction-to-physical-chemistry/

COURSE TITLE	ESSENTIALS OF ORGANIC CHEMISTRY			CREDITS	4
Course Code	CYA2702	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students will learn about molecular symmetry and molecular structural configurations	1
2.	Students will learn substitution, elimination and coupling reactions, mechanisms.	1,2
3.	Students will learn about aromatic compounds, its properties and reactions	4

Pre-requisites: Knowledge of Chemistry in undergraduate level.

MODULE 1 – MOLECULAR SYMMETRY AND POINT GROUPS (12 L)

Topicity and prostereo isomerism- Nomenclature of stereotopic ligands and faces – stereo heterotopic ligands and NMR spectroscopy - Centre of chirality- assignment of absolute stereochemistry- CIP rules, axial chirality planar chirality and helicity- descriptors for absolute stereochemistry.

MODULE 2 – CONFORMATIONAL ANALYSIS AND STEREOCHEMISTRY (12L)

Acyclic systems, cyclic systems - cyclohexane and decalins - conformation and reactivity with examples from molecular rearrangements-neighboring group participation- elimination reactions- formation and cleavage of epoxides-quantitative correlation between conformation and reactivity-Winstein Eliel equation- Curtin Hammett principle.

Classification, terminology - principle of stereoselectivity - examples of Diastereoselectivity and enantioselectivity including few examples from pericyclic reactions- Circular dichroism - ORD - cotton effect - application of ORD and CD in steroids - examples for the illustration of usefulness of cotton effect.

MODULE 3 – SUBSTITUTION REACTIONS (12L)

Nucleophilic substitution: Various types-stability and reactivity of carbocations- nucleophilicity and basicity- neighboring group participation and rearrangements- steric effects in substitution reaction-classical and nonclassical carbocations- Nucleophilic aromatic substitution- various types.

Aromatic electrophilic substitution: Intermediates and orientation - electrophiles - reactivity and selectivity-
discussion of electrophilic substitution with reference to Hammett plot- kinetic isotopic

effects. Nitration- halogenations- sulfonation- Friedel Crafts reaction- protonation.

MODULE 4 – ELIMINATION AND COUPLING REACTIONS (12L)

Synthesis of alkenes -Wittig and related reactions - modern methods of synthesis- Peterson, McMurry, Shapiro reaction - stereoselective synthesis of tri - and tetra - substituted alkenes- synthesis from 1,2-diols- pyrolytic elimination of sulfoxides and selenoxides- synthesis of alkynes, allenes and cumulenes- Pd catalysed coupling reactions- Heck, Suzuki, Glazer- Eglington coupling.

MODULE 5 - AROMATICITY AND REACTION MECHANISM (12L)

Basic definition of aromaticity - Huckle's rule- NMR as a tool-diamagnetic anisotropy- aromatic and anti-aromatic compounds – paratropy – Annulenes - some basic synthetic strategies and discussion of spectral data- alternate and nonalternate hydrocarbons.

Reaction mechanism: Definition of reaction mechanism- transition state theory- kinetics- qualitative picture - Substituent effects- linear free energy relationships- Hammett equation and related modifications- Basic mechanistic concepts like kinetic vs thermodynamic control- Hammond postulate- Curtin Hammett principle- isotope effects- general and specific acidbase catalysis- and nucleophilic catalysis.

TEXT BOOKS

1.	J. March, Advanced Organic Chemistry, 6th edition, Wiley Interscience, 2007
2.	F. A. Carey and R. I. Sundberg, Advanced Organic Chemistry, Part A, 5th edition, Plenum Press, 2007
3.	I. L. Finar, Organic chemistry, Vol-1, 6th edition, Pearson Education Asia. 2004.
4.	L.F. Fieser and M. Fieser, Organic Chemistry, Asia Publishing House, Bombay, 2000

E BOOKS

1.	https://books.google.co.in/books/about/Organic_Reaction_Mechanisms.html?id=KHIvAQAAIAAJ
2.	**http://www.chem.ucla.edu/~harding/notes/notes.html**

MOOC

1	https://www.mooc-list.com/tags/reaction-mechanisms

COURSE TITLE	CHEMICAL BONDING AND MOLECULAR GEOMETRY			CREDITS	4
Course Code	CYA2703	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Understanding the structure of atoms is a fundamental knowledge, which will make students to understand forthcoming topics.	1, 2, 3
2.	The students can get an idea of the nature of forces prevalent in compounds, other than chemical bonding.	1, 2, 3
3.	A study on the different types of crystals will make student to understand the basics of material structure, which will help in synthesis of novel materials.	2, 3, 4
4.	Exposure to indepth knowledge of chemical bonding will educate students to understand different properties of chemicals in detail.	1, 2, 3
5.	Educating the students on the various aspects of aqueous chemistry will lead to carryout chemical reactions using different suitable solvents leading to green chemistry.	3, 4, 5

Prerequisites: Knowledge in fundamentals of chemistry at under graduate level.

MOD ULE 1 – ATOMIC STRUCTURE (12L)

The Schrodinger wave equation – quantum numbers- energy level diagram of hydrogen atom and polyelectron atoms - electronic configuration and term symbols - periodic properties of elements – atomic size-ionization energy-electron affinity-electro negativity-covalent and ionic radii-magnetic properties.

Suggested Reading: Atomic theory – Atomic model- De Brogue's Equation -periodic table.

MODULE 2 – NON-VALENCE FORCES (12L)

Van deer Waals' forces - hydrogen bond – metallic bond – free electron theory of metals - ionic solids – common structures and properties of ionic compounds-ionic radius -Pauling's univalent radii - lattice energy – Born-Haber cycle - Defects structures- Band theory of solids, p-type & n-type semiconductors-superconductivity

Suggested Reading: Crystal lattice - unit cell - lattice point - chemical bonding.

MODULE – 3 : CRYSTAL STRUCTURE (12L)

Radius ratio rules- structures of AX (ZnS, NaCl, CsCl), AX_2 (TiO_2, SiO_2) A_2X_3, ABX_3 and A_2BX_4

type solids – layer structure – cadmium iodide - covalent solids – diamond, graphite.

Suggested Reading: Coordination number - Structure of metallic crystals.

MODULE 4 - COVALENT BOND (12L)

Valence bond theory – hybridization – types of hybridization- Molecular Orbital theory- symmetry and overlap – bonding in homonuclear diatomic molecules; O_2, B_2 N_2 and C_2 – bonding in heteronuclear diatomic molecules; CO and HCl - Molecular orbital of triatomic molecules; BeH_2 and NO_2 - VSEPR theory – methane, ethylene, acetylene, ammonia, water, PCl_3F_2 (Bent's rule), SF_4, BrF3, TeF_5 -, ICl_2 -, ICl_4 -, XeF_2, XeF_4, XeF_6, XeO_3, XeO_4, phosphorus trihalides bond angle, ammonia & NF_3 dipole moments, H_2O, OF_2 angle, NH_3, XeO_3 angle, CoF_2.

Suggested Reading: Concept of resonance - Concept of Promotion of Electrons – Hybridisation.

MODULE 5 – AQUEOUS CHEMISTRY (12L)

Acid base concepts -Bronsted, Lowry, Lux-Flood, Usanovich, Lewis - solvent system and generalised acid base concepts -Measures of acid -base strength -steric effect and solvation effects - Hard and soft acids and bases (HSAB) concept - Types of solvents - Liq. NH_3, alkali metals in liq. NH_3, SO_2, and HF - types of reactions - autoionisation and neutralisation, precipitation, solvation, solvolysis, and complex formation.

Suggested Reading: Acidity and Basicity of Molecules.

TEXT BOOKS

1.	F.A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 5th Edn. John Wiley & Sons, 2004.
2.	J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, 5th Edn. Pearson Education, 2005.

REFERENCE BOOKS

3.	J. D. Lee, Concise Inorganic Chemistry, 5th Edn. Blackwell Science, 2006.
4.	S. K. Basu, R. D. Madan, Prakash Satya, G. D. Tuli, Advanced Inorganic Chemistry-Vol. I, 19th Edn. S. Chand, 2006.

E BOOKS

3.	http://www.freebookcentre.net/chemistry-books-download/Introduction-to-Inorganic-chemistry.html
4.	http://www.freebookcentre.net/chemistry-books-download/Advanced-Inorganic-Chemistry-by-Robert-L.-Carter.html

MOOC

2.	https://swayam.gov.in/courses/249-inorganic-chemistry-ii
3.	https://www.mooc-list.com/course/inorganic-chemistry-saylororg

COURSE TITLE	QUANTUM CHEMISTRY AND GROUP THEORY			CREDITS	4
Course Code	CYA2704	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students will be able to solve the model problems in quantum mechanics.	1,2
2.	Relate concepts in modern atomic physics to molecular systems	2,3
3.	Determine the symmetry operations and apply point group theory to study the properties.	4,5

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – REVIEW OF OLD QUANTUM THEORY (12 L)

Postulates of quantum mechanics- Wave functions and probabilities Operators, Matrix representations- Commutation relationships- Solution of Schroedinger for exactly solvable problems such as Particle-in-a-box - particle-in-a-ring - armonic oscillator and rigid rotor - Solution of the Schroedinger equation for the hydrogen atom.

MODULE 2 – TIME INDEPENDENT PERTURBATION THEORY (12L)

Degenerate states- Variational method- Helimann - Feynman theorem-Spectra and structure of Helium atom- Term symbols for atoms-Hartree - foch equations- the self consistent method and coupling schemes.

MODULE 3 – CHEMICAL BONDING (12L)

Born-Oppenheimer approximation- Hydrogen molecule ion- Hydrogen molecule: Valence bond and molecular orbital methods- Polyatomic molecules and hybridization- Conjugated 7t-systems and Huckel theory- Frontier orbital theory- Semi empirical CNDO and ab-initio methods - configuration interaction.

MODULE 4 – GROUP THEORY (12L)

The concept of groups- symmetry equations and symmetry elements in molecules-Matrix representations of symmetry operations- Point groups- irreducible representations and character tables.

MODULE 5 – APPLICATIONS OF GROUP THEORY (12L)

Application of group theory to atomic orbital in ligand fields- molecular orbitals- hybridization - classification of normal vibrational modes- selection rules in vibrational and electronic spectroscopy.

TEXT BOOKS

1. Alan Vincent- Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications. John and Willy & Sons Ltd. 2016.
2. I N Levine, Quantum Chemistry, 7th edition, 2013.
3. Donald A Mc Quarrie, Quantum Chemistry, 2016
4. Atkins, Molecular Quantum Mechanics, 2010.
5. F.A. Cotton, Chemical Applications of Group Theory, Wiley NY, 2016.

E BOOKS

1. http://store.doverpublications.com/0486432475.html

MOOC

1. https://onlinecourses.nptel.ac.in/noc16_cy07/preview

COURSE TITLE	ANALYTICAL CHEMISTRY			CREDITS	3
Course Code	CYA2705	Course Category	CC	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Apply the statistical method to assess the data quality.	1
2.	Acquires knowledge on the quantitative estimation of analyte by gravimetric method.	1,2
3.	Gains an understanding on the general principles and theory of spectroscopy.	1,2
4.	Understanding the basic reaction involved in different types of titrations.	2,3
5.	Understands the various separation techniques and purification techniques.	2,4

Prerequisites : Knowledge of instruments and analysis in undergraduate level.

MODULE 1 – ERRORS IN MEASUREMENT (9 L)

Statistical tests and Error Analysis: Accuracy, precision, classification of errors-minimization of errors-significant figures and computation-mean deviation and standard deviation-Gaussian distribution- frequency distributions, the binomial distribution, the Poisson distribution and normal distribution, criteria for rejection of data, Q-test, T test and F-test, control chart, sampling methods, sampling error, statistical data treatment, standard reference materials.

MODULE 2 – GRAVIMETRY (9L)

Theory of gravimetric analysis -Introduction, solubility, solubility product-common ion effect, precipitation methods - Principles – instrumentations and applications of thermogravimetry analysis(TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – thermometric titrations – types – advantages.

Suggested Reading: N. Gray, M. Calvin and S.C. Bhatia, Instrumental Methods of Analysis, CBS Publishers, 2009.

MODULE 3 - TITRIMETRY (9L)

Acid Base titrations: Classification-theory of acidbase titration-naturalization indicators-mixed indicators – universal indicators -neuturalization curves -choice of indicators in neutralization reactions.

Complexometric titrations: Stability of complexes – factors influencing the stability of complexes-stability constants of EDTA complexes-titration curves-selectivity-masking and demasking agents-

metal ion indicators.

Precipitation titrations: Theory of precipitation reactions -determination of end point in precipitation reactions.

Oxidation reduction titration: Theory-change of electrode potential during the titration of a reductant with an oxidant-formal potentials-detection of end points in oxidation reduction titrations-titrations in non aqueous media

Suggested Reading: G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, 2007.

MODULE 4 – COLORIMETRY&SPECTROPHOTOMETRY (9L)

Standard series method -duplication method -balancing method -photoelectric colorimeter -spectrophotometer – single beam-double beam -determination of pKa value of an indicator-simultaneous spectrophotometric determination.

Flame spectrometry: Instrumentation, combustion flames-nebuliser burner system-resonance line sources – monochromator -detector – types of interferences –comparison -single beam AAS -double beam AAS nonflame techniques -cold vapour AAS.

Suggested Reading: G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, 2007.

MODULE 5 – ANALYTICAL SEPARATION AND PURIFICATION TECHNIQUES (9L)

Precipitation, distillation, solvent extraction and separation processes, partition chromatography, column chromatography, thin layer chromatography (TLC), paper chromatography and their applications.Ion exchange chromatography: principle, instrumentation with special reference to separation and suppressor columns and applications. Principles, instrumentation and applications of GC, LC, and HPLC, signal to noise ratio, sources of noise in instrumental analysis.

Suggested Reading G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, 2007.

TEXT BOOKS

1.	D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis,Thomson Learning, 2007.
2.	H. H. Willard, L. Jr. Merritt., J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, 7th Ed., CBSPublishers, 2007.
3.	R.M. Verma, Analytical Chemistry Theory and Practice, 3rd Ed., CBS Publishers, 1994. B. K. Sharma, Instrumental Methods of Analysis, 28th Ed., GOEL Publishing House, 2012.
4.	D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry,9th Ed., Brooks Cole, 2013.
5.	N. Gray, M. Calvin and S.C. Bhatia, Instrumental Methods of Analysis, CBS Publishers, 2009.
6.	G. D. Christian, Analytical Chemistry, 6th Ed., Wiley, 2007.
E BOOKS	
1.	http://www.freebookcentre.net/Chemistry/Analytical-Chemistry-Books.html
MOOC	
1.	https://www.mooc-list.com/tags/analytical-chemistry

COURSE TITLE	PHYSICAL CHEMISTRY PRACTICAL			CREDITS	3
Course Code	CYA2731	Course Category	CP	L-T-P-S	0-0-6-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students will learn to do instrument based estimations and analysis.	3,4
2.	Students learn to calculate kinetics of chemical reactions.	3,4
3.	Students learn to create phase diagram of 2 component systems	4,5

Pre-requisites : Knowledge of Chemistry in undergraduate level.

LAB / MINI PROJECT/FIELD WORK

1. Conductometric titration – mixture of acids.
2. Potentiometric titration – estimation of ferrous ion.
3. pH metric titration – estimation of purity of ascorbic acid.
4. Determination of critical solution temperature of heterogeneous (phenol-water) system
5. Determination of pK value of an acid base indicator and salting out constant.
6. Determination of activity co-efficient of an electrolyte at different concentrations by emf measurements
7. Spectrophotometric estimation of iron, Mn in solutions
8. Degree of hydrolysis of aniline hydrochloride.
9. Basicity of an acid. Verification of Ostwald dilution law using weak acid and determination of its dissociation constant.
10. Determination of order - acetone-iodine reaction;
11. Determination of rate constant-saponification of ethyl acetate;
12. Study of primary salt effect on the kinetics of ionic reaction
13. Phase diagram of ternary system (nitrobenzene-acetic acid-water)
14. Abbe's refractometer- Percentage composition of binary mixtures

TEXT BOOKS

1.	D. P. Shoemaker and C. W. Garland, Experiments in Physical Chemistry, 6th, Edition, McGraw- Hill, 1996.
2.	Daniels, F., R. A. Alberty, J. W. Williams, C. D. Cornwell, P. Bender, and J. E. Harriman, Experimental Physical Chemistry, McGraw-Hill Inc., New York, 1975

E BOOKS

1.	https://pubs.acs.org/doi/abs/10.1021/ed008p1009.2

MOOC

1	https://www.mooc-list.com/tags/chemistry

COURSE TITLE	CHEMICAL KINETICS AND CATALYSIS			CREDITS	4
Course Code	CYA2711	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Strengthen the basics of kinetics and to apply the concept to complex reactions	1
2.	The learners should be able to apply elementary laws of chemical kinetics and analyze reaction mechanisms and changes in transport properties of chemical reactions and collision processes.	1
3.	Knowledge on the kinetics of photochemical reactions will enable student to carryout photochemical reactions, and to device new catalysts which are active for self-cleaning technology.	2
4.	Able to calculate the rate equation for acid-base catalyzed reactions and enzyme catalyzed reaction.	3,4
5.	Exposure on the surface chemistry and heterogeneous catalysis will make the student to understand and design new catalysts for industrially important reactions, and for green chemical processes.	4,5

Prerequisites : Basic knowledge in Kinetics in undergraduate level

MODULE 1 – KINETICS OF REACTIONS (12L)

Terminologies- Order of reaction - determination - Complex reactions: opposing reactions, parallel reactions and consecutive reactions – chain reactions - flame and explosion temperatures - Study of fast reactions, flow technique, stopped flow technique, temperature and pressure jump methods, shock tubes.

Suggested Reading: Terminologies

MODULE 2 – THEORY OF REACTION RATES (12L)

Effect of temperature on reaction rates, Arrhenius equation for simple reactions, Energy of activation. Potential energy surfaces, an introduction, Kinetic theory of collisions- collision cross section, comparison with Arrhenius equation, Conventional transition state theory, thermodynamic treatment, Eyring equation, - Elementary gas phase reactions: Lindemann - Hinsheldwood mechanism and Rice Ramsperger Kassel (RRK) theory.

Suggested Reading: Rate equation , rate law

MODULE – 3 KINETICS OF PHOTOCHEMICAL REACTIONS (12)

Kinetics in the excited electronic states-Jablonskii diagram-kinetics of unimolecular photophysical and photochemical processes-Photostationary states-photoisomerisation-bimolecular photophysical and photochemical processes-excimers, exciplexes and sensitization-Mechanism of fluorescence quenching SternVolmer equation.

Suggested Reading: Physical and chemical processes in photochemical reactions

MODULE – 4 : HOMOGENEOUS CATALYSIS (12L)

Acid-Base Catalysis: Specific and general catalysis- Skrabal diagram- prototropic and protolytic mechanisms- secondary salt effect- examples- Acidity function: Ho H-scales- Overlap method - Enzyme catalysis- Michaelis-Menten equation - Lineweaver-Burk and Eadie plots- Effect of temperature and pH, transient - phase kinetics

Suggested Reading: Effect of catalyst, catalyst activity

MODULE 5 – SURFACE CHEMISTRY & HETEROGENEOUS CATALYSIS (12L)

Adsorption – gas on solid – types of adsorption – Freundlich, Langmuir, B.E.T adsorption isotherms, applications: adsorption chromatography, purification of water by zeolites, etc. Surface Reactions: thermodynamics of surface reactions, Langmuir Hinshelwood and EleyRideal mechanisms. General aspects, co adsorption, poisoning and promotion effects, model reactions. Industrially important surface catalyzed reactions -examples CO oxidation and methanation, ammonia synthesis, epoxidation reactions

Suggested Reading: Adsorption, gas on solid, types of adsorption

TEXT BOOKS

1.	Peter Atkins, Julio de Paula, Elements of Physical Chemistry, fourth edition, W.H. Freeman & Company, 2005
2.	G. M. Barrow, Physical Chemistry (V Edition), Tata McGraw Hill Education, 2007

REFERENCE BOOKS

	Keith J. Laidler, Chemical Kinetics, Third Edition, Pearson Education, 2004.
2.	J. Rajaram and J. C. Kuriacose, "Kinetics and Mechanisms of Chemical Transformations". Macmillan India; 1993, reprint 2011.

E BOOKS

1.	Introductory Physical Chemistry **by** David Ronis - McGill University **,** 2011
2.	Physical Chemistry in Brief**y** J.P. Novak, S. Labik, I. Malijevska - Institute of Chemical Technology, Prague **,** 2005

MOOC

1.	https://www.my-mooc.com/en/mooc/introduction-to-physical-chemistry/

COURSE TITLE	ORGANIC REACTIONS			CREDITS	4
Course Code	CYA2712	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students will learn about pericyclic and condensation reactions	1,2
2.	Students will learn about carbonyl compounds, preparation and reactions	2,3
3.	Students will learn about addition reaction and photochemical reaction of organic compounds.	4,5

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – PERICYCLIC REACTIONS (12 L)

Classification-electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions- Woodward - Hoffmann rules- Frontier orbital and orbital symmetry correlation approaches, examples- Mechanism – General mechanistic considerations - nature of migration - migratory aptitude - nucleophilic, electrophilic and free radical rearrangements- Wagner Meerwein, Dienone –phenol, Wolf, Lossen, Schmidt, Bayer-Villiger, Stevens, Wittig, Favorski rearrangements.

MODULE 2 – CARBONYL COMPOUNDS (12L)

Modern methods of synthesis from alcohols- Swern and Dess Martin oxidations- Reactions of carbonyl compounds, addition of N,O, and S nucleophiles-Reduction using hydride reagents – chemo - and stereoselectivity - formation of enols and enamines- kinetic and thermodynamic enolates.

MODULE 3 – CONDENSATION REACTIONS (12L)

Lithium and boron enolates in aldol and Michael reactions- stereoselective aldol condensations-alkylation and acylation of enolates - Claisen, Dieckman, Knoevenagel, Stobbe and Darzen glycidic ester, acyloin, emphasis on synthetic utility of these reactions- rearrangement reactions involving electron deficient carbon, nitrogen, oxygen centers, the synthetic utility of these rearrangements.

MODULE 4 – ADDITION REACTIONS (12L)

Reactions of alkenes and alkynes – stereo and enantioselective hydroboration-hydrogenation, Epoxidation (Sharpless, Jacobson methods)- hydroxylation- oxymercuration-halolactonisation- Preparation and synthetic uses of lithium and copper acetylides.

MODULE 5 - PHOTOCHEMICAL REACTIONS (12L)

Photofragmentation- photoaddition- Type I and Type II cleavage- photosubstitution, cycloaddition, Paterno Buchi reaction, isomerization and rearrangement reactions- photoreduction and photooxidation reactions- singlet oxygen and chemiluminescence – Photoinduced electron transfer reactions – application to solar energy conservation and artificial photosynthetic systems- Photochemical substitution in transition metal complexes- organometallic photo chemistry- substitution of metal carbonyls.
LAB / MINI PROJECT/FIELD WORK
NA
TEXT BOOKS

1.	S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.
2.	F. A. Carey and R. I. Sundberg, Advanced Organic Chemistry, Part A, 5th edition, Plenum Press, 2007
3.	SM. B. Smith, Organic Synthesis, 2nd Edition, 2005
4.	L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.
E BOOKS	
1.	http://www.freebookcentre.net/Chemistry/Organic-Chemistry-Books.html
MOOC	
1.	https://www.mooc-list.com/tags/organic-chemistry
2.	https://www.cliffsnotes.com/study-guides/chemistry/organic-chemistry-ii

COURSE TITLE	INORGANIC ELEMENTS AND SOLID STATE CHEMISTRY			CREDITS	4
Course Code	CYA2713	Course Category	CC	L-T-P-S	3-1-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1	Understanding the s-block and p-block elements are very much essential for students to carryout research in inorganic materials and for ceramic industries.	1, 2, 3,4
2	The students can get an idea to prepare transition metal catalysts, since they have variable oxidation states.	1, 2, 3
3	Educating the students on the chemistry of f-block elements will make them to understand the compounds formed by these elements and their uses in strategic sectors.	2, 3, 4
4	A study on the chemistry of non-metals will make the students to understand the preparation methods of industrially important chemicals like boranes, silanes, phosphanes, etc.	3, 4, 5
5	Exposure to solid-state chemistry is an important topic to understand basics of crystals and the students can do research on crystal growth for various applications.	3, 4

Prerequisites: Knowledge in periodic properties of elements, bonding and molecular geometry.

MODULE 1 – CHEMISTRY OF s-BLOCK & p-BLOCK ELEMENTS (12L)

General characteristics of s-block elements - atomic and physical properties - Alkali metals: physical properties and chemical properties - reactions with oxygen, hydrogen, halogens. Alkaline earth metals: physical and chemical properties - reactions with oxygen, hydrogen and halogens - Anomalous properties of lithium and beryllium.

General characteristics of p-block elements: atomic and physical properties - Physical and chemical properties of Boron and its compounds (borax, boric acid). Carbon: Allotropes, properties, oxides of Carbon. Nitrogen: properties and chemical reactivity. Ammonia: Haber process of manufacture, properties and uses. Oxygen: properties and chemical reactivity.

Suggested Reading: Occurrence and abundance - Periodic properties of s- and p-block elements.

MODULE 2 – CHEMISTRY OF d-BLOCK ELEMENTS (12L)

Electronic configuration and general characteristics -metallic properties, ionization energy, electrode potential, oxidation states, ionic radii, catalytic properties, coloured ions, complex formation, magnetic properties, interstitial compounds and alloys. Preparation and properties of $KMnO_4$, $K_2Cr_2O_7$.

Suggested Reading: Occurrence and abundance - Periodic properties of d-block elements.

MODULE 3 – CHEMISTRY OF f-BLOCK ELEMENTS (12L)	
Lanthanides – occurrence-isolation-lanthanide contraction-oxidation states-spectral and magnetic properties-coordination complexes-actinides-configuration, properties-nuclear reactions of uranium, thorium and plutonium-power generation by nuclear reactors-breeder reactor-fusion reaction-radioisotopes and their applications. Suggested Reading: Abundance and number of isotopes – Electronic structure - Periodic properties of f-block elements.	
MODULE 4 – CHEMISTRY OF NON-METALS (12L)	
B, Si, P & S compounds - E-H, E-X, E-O & E-N bond types in different molecules - chemistry of simple boranes, silanes, phosphanes and sulphanes borazine, boron and silicon nitrides. P-N & S-N rings: Synthesis, structure & bonding reactions of $N_3P_3Cl_5$ & S_4N_4 -Halogen and noble gas chemistry: Interhalogen, pseudohalogen ionic oxyhalogen species, xenon-oxides & fluoxides. Suggested Reading: Occurrence and structure of the elements – Physical and chemical properties.	
MODULE 5 – SOLID-STATE CHEMISTRY (12L)	
Cyrstallography-laws of crystal structures, crystal systems, X-Ray crystallography -X-Ray, neutron and electron diffraction, types of crystalline solids -Preparative methods: Solid state reaction - precipitative reactions, sol-gel route – Superconductivity and recent high Tc materials -spinels, gamets and perovskites-glasses and refractories. Suggested Reading: Metallic bond and metallic structure – theories of bonding in metals.	
TEXT BOOKS	
1	F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 5th Edn. John Wiley & Sons, 2004.
2	J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, 5th Edn. Pearson Education, 2005.
REFERENCE BOOKS	
1	J. D. Lee, Concise Inorganic Chemistry, 5th Edn. Blackwell Science, 2006.
2	S. K. Basu, R. D. Madan, Prakash Satya, G. D. Tuli, Advanced Inorganic Chemistry-Vol. I, 19th Edn. S. Chand, 2006.
E BOOKS	
1	http://www.freebookcentre.net/chemistry-books-download/Advanced-Inorganic-Chemistry-I.html
2	http://www.freebookcentre.net/chemistry-books-download/Principles-of-Inorganic-Chemistry-III.html
MOOC	
1	https://swayam.gov.in/courses/249-inorganic-chemistry-ii
2	https://www.mooc-list.com/course/inorganic-chemistry-saylororg

COURSE TITLE	MOLECULAR SPECTROSCOPY			CREDITS	3
Course Code	CYA2714	Course Category	CC	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students gain knowledge in the interaction of radiation with matter.	1
2.	Able to use the quantum mechanics and group theory principle to understand the molecular spectra.	1
3.	Students acquires knowledge on the principle and application of NMR.	2
4.	Determines the structure of compounds based on the spectra.	2,3
5.	Able to find the molecular mass and identify the structure of compound using mass spectroscopy.	3,4

Prerequisites : Basic knowledge of spectroscopy in undergraduate level.

MODULE 1 – INTERACTION OF ELECTROMAGNETIC RADIATION WITH MATTER (9L)

Interaction of matter with radiation-time dependent perturbation theory-Einstein coefficients-Energy levels and transition probabilities for the rigid rotor harmonic oscillator model -Potential energy surfaces in the ground and excited electronic states-Franck Condon principle

Suggested Reading: C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.

MODULE 2 – ROTATIONAL AND VIBRATIONAL SPECTROSCOPY (9L)

Rotational and vibrational spectroscopy of polyatomic molecules-angular momentum operator matrix elements, energy levels and transition probabilities for symmetric and asymmetric top molecules-normal modes of vibration and their classification by group theory-Coupling between rotational and vibrational degrees of freedom-Elementary introduction-Electronic spectra of poly-atomic molecules-absorption and emission spectroscopy-charge transfer spectra-effect of solvent-Raman Spectroscopy.

Suggested Reading: C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.

MODULE – 3 : NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (9L)

General introduction and definition − Chemical shift, spin-spin interaction, shielding mechanism,

chemical shift values and correlation for protons bonded to carbon complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin Fourier transform technique. Carbon-13 NMR Spectroscopy – General considerations, chemical shift - coupling constants. nuclear overhauser effect (NOE).

Suggested Reading: C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.

MODULE – 4 : ELECTRON SPIN RESONANCE SPECTROSCOPY (9L)

Electronic Zeeman and hyperfine interactions-hydrogen atom in a magnetic field-election rules in ESR-anisotropy and hyperfine constants-hybridization-ESR of organic free radicals in solution-McConnel's relations.

Suggested Reading: K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.

MODULE 5 – MASS SPECTROMETRY (9L)

Basic principle-ionization methods, isotope abundance, molecular ions, fragmentation processes of organic molecules and deduction of structural information-high resolution MS-introduction to soft ionization techniques and illustrative examples in Macromolecular and supra molecular chemistry.

Suggested Reading: I. N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.

LAB / MINI PROJECT/FIELD WORK

N/A

TEXT BOOKS

1.	K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.
2.	C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.
3.	Colin N. Banwell, Elaine M. McCash Edition: Paperback (4th), Mcgraw-Hill College, 2006.
4.	I. N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.

E BOOKS

1.	https://www.elsevier.com/books/molecular-spectroscopy/rao/978-0-12-580640-4

MOOC

1.	https://www.mooc-list.com/course/introduction-molecular-spectroscopy-coursera

COURSE TITLE	NUCLEAR CHEMISTRY AND BIOMOLECULES			CREDITS	3
Course Code	CYA2715	Course Category	CC	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1	Students will learn about the structure of nucleus of the atom and its radioactivity.	1, 2, 3
2	Students learn different types of nuclear reactions.	1, 2, 3
3	Students learn about the analytical techniques using nuclear chemistry.	2, 3, 4
4	Knowledge on lipids and enzymes are essential for the students to learn about enzyme catalysis and membrane separation techniques, etc.	3, 4, 5
5	Knowledge on the different types of minerals and their role in human body can make the student to understand function of human body.	4, 5

Prerequisites: Knowledge in fundamentals of structure, properties and functions of biomolecules.

MODULE 1 – THE NUCLEUS (9L)

The subatomic particles: electron, proton, neutron, antiproton, positron, meson, quacks - Mass of nuclei: isotopes, isobars, mass spectrometry- identification of isotopes-Radius of atomic nuclei-binding energy of nuclei-force between nucleons- Nuclear moment nuclear angular momentum, nuclear magnetic dipole moment, electric quadrupole moment – NQR- Nuclear models: liquid drop model, nuclear shell model, fermi gas model.

MODULE 2 – RADIOCHEMISTRY (9L)

Radioactive series decay: radioactive series growth and decay, determination of half –lives-Alpha decay: theory of emission, alpha-ray energy spectra-Beta-decay: decay theory, electron capture, double beta decay-Gamma ray: theory of emission, internal conversion, the Auger effect, nuclear resonance absorption. Pr inciples of Mossbauer spectroscopy-Counters: Geiger counters, scintillation counters, proportional counters, semiconductor detectors.

MODULE 3 - NUCLEAR REACTION (9L)

Types of nuclear reactions: reaction cross section-compound nucleus theory, high energy nuclear, direct nuclear, photonuclear and thermonuclear reactions- Source of nuclear bombarding particles: Charged particle accelerators, gamma ray, X ray and neutron sources- Fission: Fission products and Fission yield curve, Fission energy, theory of nuclear fission, nuclear reactor , breeder reactor - nuclear reactors in India. Fusion reactions hydrogen bomb and energy of sun - Transuranium elements: Synthesis, separation and properties of Tranuranium elements- Reprocessing of spent fuels. Solvent Extraction - Specific sequestering agents for Transuranium elements.

MODULE 4 - LIPIDS AND ENZYMES (9L)

Common class of lipids-self association of lipids-Formation of micelles-membranes-bilayer and hexagonal phases-Membrane bound proteins structure-properties and transport phenomena – Enzymes – classification – characteristics - functions- catalysis- thermodynamic and kinetic considerations -enzyme kinetics - Michelis Menton equation -inhibition of enzyme action.

Suggested Reading: Structure and functions of lipids – membrane transport mechanism – active and passive transport – Classification and functions of enzymes.

MODULE 5 – PHYSIOLOGICAL BIOCHEMISTRY (9L)	
Minerals – classification - biological roles of minerals - calcium biochemistry-oxygen transport and storage-carbonic anhydrase-carboxypeptidases- FeS proteins and non-heme iron-cytochromes of the electron transport chain- oxidative phosphorylation - cytochrome P-450 enzymes-coenzyme B12-nitrogen fixation and photosynthesis. Suggested Reading: Common class of minerals - Biological importance of minerals – Hemoglobin –structure and functions.	
LAB / MINI PROJECT/FIELD WORK	
N/A	
TEXT BOOKS	
1.	Albert L. Lehninger, David L. Nelson, Michael M. Cox. Principles of Biochemistry, CBS Publishers and Distributors, 1st Indian Edition, Delhi, 1993.
2.	Satyanarayana, U, Chakrapani, U. Biochemistry, 3rd Edition, Books and Allied Pvt. Ltd, 2006.
3.	H. J. Arnikar, "Essentials of Nuclear Chemistry", Wiley Eastern Ltd., New Delhi, 2012.
4.	A.K. Srivatsava and P. Jain, "Essential of nuclear Chemistry", S.Chand, N.Delhi, 2009.
REFERENCE BOOKS	
1.	A. L. Lehninger, Biochemistry: The molecular Basis of cell structure and function, Worth Publishers, 1982.
2.	1. R. J. Simond, Chemistry of Biomolecules, Royal Society of Chemistry, U.K. London, 1992.
E BOOKS	
1.	http://www.freebookcentre.net/chemistry-books-download/Macromolecules.html
2.	http://www.freebookcentre.net/chemistry-books-download/Membranes.html
3.	http://www.freebookcentre.net/Chemistry/Nuclear-Chemistry-Books.html
MOOC	
1.	https://www.mooc-list.com/course/principles-biochemistry-edx
2.	https://www.edx.org/course/principles-biochemistry-harvardx-mcb63x-1
3.	https://www.mooc-list.com/tags/nuclear

COURSE TITLE	INORGANIC CHEMISTRY PRACTICAL			CREDITS	3
Course Code	CYA2741	Course Category	CP	L-T-P-S	0-0-6-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students learn to analyze water quality parameters.	4,5
2.	Students learn determination of anions and cations in the given salt.	4,5
3.	Students learn technical analysis of inorganic compounds	4,5

Pre-requisites: Knowledge of Chemistry in undergraduate level.

LAB / MINI PROJECT/FIELD WORK

1. Qualitative inorganic semi micro analysis- Detection of four cations in a mixture of salt.
2. Total dissolved solids
3. Carbonate and non-carbonate hardness by EDTA
4. Dissolved oxygen, BOD, COD
5. Alkalinity in the given water
6. F, Cl, SO_4^{2-}, Fe^{3+}
7. Turbidity
8. Iodimetry
9. Alloys: ferrous and nonferrous alloys-brass and solder
10. Spectrophotometry- estimation of copper, nickel, iron and manganese
11. Active CaO in lime
12. Chlorine in bleaching powder
13. Analysis of cement -silica, mixed oxide – Fe_2O_3, Al_2O_3 & CaO/MgO.
14. $BaSO_4$ in lithophone.

TEXT BOOKS

1.	G.Srehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, Orient Longman, New Delhi, 1982.
2.	J.Basset, R.C.Denny, C.H.Jeffery and Mendham, Vogel's Textbook of Quantitative Inorganic analysis, including Elementary Instrumental Analysis, ELBS, London, 1978

E BOOKS

1.	https://pubs.acs.org/doi/abs/10.1021/ed011p62.2

MOOC

1.	https://www.mooc-list.com/tags/inorganic-chemistry

COURSE TITLE	ELECTROCHEMISTRY AND ELECTRODICS			CREDITS	4
Course Code	CYA2801	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The learners should be able to: Write equations representing electrochemical cell, explain various overpotential involved during the operation of the cell. Calculate electrochemical cell parameters, amount of corrosion and its rate	1
2.	Knowledge on the different types energy storage devices will enable the students to work on alternate energy sources, which is need of the hour, especially renewable energy sources.	1,5
3.	The learners should be able to apply theories in electrochemistry to analyze electrode kinetics.	2
4.	the learners should be able to Plot potential vs current, surface coverage vs. potential, potential vs. pH, concentration profile vs. distance from the electrode	2,3
5.	Educating the students on the various types of electroanalytical techniques, will make them to understand the basics of analytical methods, so that they can easily work in any analytical laboratories.	3,4

Prerequisites: Basic knowledge in undergraduate level electrochemistry**.**

MODULE 1 – ELECTROCHEMISTRY AND CORROSION (12L)

Thermodynamic aspects of electrochemical cell-Types of electrode-Liquid junction potential-applications of emf measurements.

Corrosion: Different types of corrosion; influence of environment; Evans diagram, Pourbaix diagram; corrosion rate measurements; Stern Geary equation; mixed potential theory and prevention of corrosion.

Suggested Reading: Basic terminologies of electrochemistry

MODULE 2 – ENERGY STORAGE DEVICES (12L)

Energy sources – advantages and disadvantages – environmental effects – comparative evaluation of energy options and energy needs – fuel cells – classification – chemistry of fuel cells – H_2-O_2 , CH_3OH – O_2 , molten carbonate – solid polymer electrolyte-biochemical fuel cells – principles, construction and applications -Hydrogen as fuel-production – thermal, electrolysis – photolysis and photochemical methods – storage of Hydrogen and applications of H_2 as fuel.

Suggested Reading: Various energy sources, advantages and disadvantages

MODULE 3 - ELECTROLYTIC CONDUCTANCE (12L)

Independent migration of ions - determination of ionic conductance, Transference numbers and its determination - solvent effect on conductance, influence of temperature and pressure of

ionic conductance- Walden's equations - Abnormal ion conductance.

Suggested Reading: Conductance, its determination and applications

MODULE 4 - ELECTRODICS & DYNAMIC ELECTROCHEMISTRY (12L)

Thermodynamics of electrified interface, Lippmann equation, electrocapillary curves, surface excess, determination of surface excess, structure of electrical double layer, Helmholtz-Perrin model, Guoy-Chapman model, Stern model. Butler Volmer equation for simple electron transfer reaction, current density, Tafel equation, Theories of overvoltage and its determination, factors affecting overvoltage, exchange current density, polarization.

Suggested Reading: Basics in electrodics

MODULE 5 - ELECTRO ANALYTICAL TECHNIQUES (12L)

Reference electrodes: polarizable and non-polarizable systems. Types of reference and working electrodes. Polarography - principles and applications. Electrogravimetry and coulometry-Voltammetry – amperometric titrations and anodic stripping voltammetry – polarography-AC polarography – square wave polarography – RF polarography – normal and differential pulse polarography -principles-practice and applications.

Suggested Reading: polarizable and non-polarizable systems

LAB / MINI PROJECT/FIELD WORK

N/A

TEXT BOOKS

1.	Peter Atkins, Julio de Paula, Elements of Physical Chemistry, fourth edition, W.H. Freeman & Company, 2005
2.	G. M. Barrow, Physical Chemistry (V Edition), Tata McGraw Hill Education, 2007

REFERENCE BOOKS

1.	S. Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi 2003.
2.	Puri Br, Sharma Lr, Madan S Pathania; Principles of Physical Chemistry, Vishal Publishing Co, 2008.

E BOOKS

1.	Introductory Physical Chemistry by David Ronis - McGill University , 2011
2.	Physical Chemistry in Brief by J.P. Novak, S. Labik, I. Malijevska - Institute of Chemical Technology, Prague , 2005

MOOC

1.	https://www.my-mooc.com/en/mooc/introduction-to-physical-chemistry/

COURSE TITLE	REAGENTS AND ORGANIC SYNTHESIS			CREDITS	4
Course Code	CYA2802	Course Category	CC	L-T-P-S	3-1-0-0
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Chemistry of retro synthetic analysis, for understanding the synthesis of pharmaceutical drugs	1,2
2.	Knowledge on the reagents in organic synthesis to understand the mechanism, functions and suitability for various types of organic reactions under different conditions.	2,3
3.	Exposure on the terpenoids and steroids, essential in synthesizing very important drugs.	4
4.	Exposed on the terpenoids and steroids, that are very essential in synthesizing important drugs.	4,5

Pre-requisites: Knowledge of Chemistry in undergraduate level.

MODULE 1 – RETRO SYNTHESIS AND PROTECTING GROUPS (12 L)

Retrosynthetic Analysis: Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions

Protecting groups: Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds; chemo- and regioselective protection and deprotection; illustration of protection and deprotection in synthesis.

MODULE 2 – OXIDATIONS (12L)

Oxidation: Metal based and non-metal based oxidations of (a) alcohols to carbonyls (Chromium, Manganese, aluminium, silver, ruthenium. DMSO, hypervalent iodine and TEMPO based reagents). (b) phenols (Fremy's salt, silver carbonate) (c) alkenes to epoxides (peroxides/per acids based), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation.(d) alkenes to diols (Manganese, Osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification, (e) alkenes to carbonyls with bond cleavage (Manganese, Osmium, Ruthenium and lead based, ozonolysis) (f) alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, selenium, chromium based allylic oxidation) (g) ketones to ester/lactones (Baeyer-Villiger).

MODULE 3 – REDUCTIONS (12L)

Reduction: (a) Catalytic hydrogenation (Heterogeneous: Palladium / Platinum / Rhodium / Nickel etc; Homogeneous: Wilkinson). Noyori asymmetric hydrogenation. (b) Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium, Zinc, Titanium and

Samarium (Birch, Pinacol formation, McMurry, Acyloin formation, dehalgenation and deoxygenations) (c) Hydride transfer reagents from Group III and Group IV in reductions. (i) $NaBH_4$ triacetoxyborohydride, L-selectride, K-selectride, Luche reduction; $LiAlH_4$, DIBAL-H, and Red-Al, Trialkylsilanes and Trialkylstannane, Meerwein-Pondorff-Verley reduction) (ii) Stereo/enantioselectiviey reductions (Chiral Boranes, Corey-Bakshi-Shibata).
MODULE 4 – CURRENT SYNTHETIC METHODS (12L)
Baylis-Hillman reaction, Henry reaction, Nef reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction and Ugi reaction. Brook rearrangement; Tebbe olefination. Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi and Sonogashira, Nozaki-Hiyama, Buchwald-Hartwig, Ullmann coupling reactions, directed ortho metalation. Aza-Cope rearrangement (Overman rearrangement), ene reaction (metallo-ene; Conia ene); Prins reaction.
MODULE 5 - TERPENOIDS AND STEROIDS (12L)
Classification – isolation of terpenes – isoprene rule- methods of structural elucidation - Synthesis and structure of monoterpines and sesquiterpenes- bisabolene, transchrysanthamic acid, logifolene, taxines, caryophyilene – Steroids- Structural elucidation and stereochemistry - cholestrol, ergosterol, estrone, progestereone, androstereone, cortisone - Prostaglandins, F21 and E2, thromboxane Tx, B2.
LAB / MINI PROJECT/FIELD WORK
NA

TEXT BOOKS	
1.	S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.
2.	F. A. Carey and R. I. Sundberg, Advanced Organic Chemistry, Part A, 5th edition, Plenum Press, 2007
3.	SM. B. Smith, Organic Synthesis, 2nd Edition, 2005
4.	L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.
E BOOKS	
1.	http://www.freebookcentre.net/Chemistry/Organic-Chemistry-Books.html
MOOC	
1.	https://www.mooc-list.com/tags/organic-chemistry

COURSE TITLE	COORDINATION AND ORGANOMETALLIC CHEMISTRY			CREDITS	4
Course Code	CYA2803	Course Category	CC	L-T-P-S	3-1-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-5			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1	The students would have understood the chemistry of coordination compounds so that they can learn about their stability, and analytical methods.	1, 2, 3
2	Knowledge on the theories of metal-ligan bond, will make students to understand and design new complexes for special applications. .	1, 2, 3
3	Knowledge on the spectral characterization of coordination compounds will help students to understand the methods to analyze complexes and to understand their stabilities.	3, 4, 5
4	Exposure on the reactivity of coordination compounds is very essential in synthesizing very important drugs to cure specific diseases.	3, 4, 5
5	Knowledge on bioinorganic chemistry will help students to understand the role of inorganic materials in biological systems.	1, 2, 3

Prerequisites: Knowledge in chemical bonding and molecular geometry.

MODULE 1 – COORDINATION COMPOUNDS (12L)

Nomenclature; coordination geometry and isomerism – structural and stereoisomerisms-absolute configuration – ORD and CD spectra -stability of complexes – successive and overall formation constants -experimental methods – polarography and potentiometry-thermodynamic aspects.

Suggested Reading: Molecular Compounds – Ligands or Coordinating Groups – Coordination number - Chelation.

MODULE 2 – THEORIES OF METAL LIGAND BOND (12L)

Valence bond theory – hybridization-crystal field theory – crystal field splitting-crystal field stabilization energy – thermodynamic, structural, spectral and magnetic characteristics-Jahn-Teller effect-ligand field theory-molecular orbital theory – pi bonding.

Suggested Reading: Stability of complex compounds in aqueous solution.

MODULE 3 – SPECTRAL CHARACTERIZATION OF COORDINATION COMPOUNDS (12L)

Free ion terms-transformations in crystal field, energy diagrams in weak and strong field cases – Tanabe-Sugano diagrams-selection rules-magnetic properties – Van Vleck equation-magnetic susceptibility – Guoy and Faraday methods-ESR spectra of transition metal ions.

Suggested Reading: Crystal field effect - Electron spin resonance (*ESR*) *spectroscopy.*

MODULE 4 – REACTIVITY OF COORDINATION COMPOUNDS (12L)

Inert and labile complexes-substitution reactions in square-planar and octahedral complexes – factors affecting reactivities - electron transfer reactions-outer sphere and inner sphere mechanisms-photochemical reactions of coordination compounds – substitution, redox and rearrangement reactions.

Suggested Reading: Ligand substitution reaction – redox reactions – photochemical reactions.	
MODULE 5 – BIOINORGANIC CHEMISTRY (12L)	
Transport proteins: Oxygen carriers, metalloenzymes, carboxy peptidase, carbonic anhydrase, redox process, iron-sulphur proteins, chlorophyll, salient features of the photo synthetic process, vitamin B12 role of sodium, potassium, calcium, zinc and copper; fixation of nitrogen, nitrogen cycle. Anti-cancer drugs and their mechanism of action, Natural and manmade radio isotopes and their application. Suggested Reading: Storage and transportation of O_2 and CO_2 by hemoglobin - electron transport chain- oxidative phosphorylation.	
LAB / MINI PROJECT/FIELD WORK	
N/A	
TEXT BOOKS	
1.	F.A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 5th Edn. John Wiley & Sons, 2004.
2.	J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, 5th Edn. Pearson Education, 2005.
REFERENCE BOOKS	
1.	W. L. Jolly, "Modern Inorganic Chemistry", 2nd Edn., Tata McGraw-Hill Pub.Co., 2007.
2.	G. E. Rodgers, Introduction to Coordination, Solid State and Descriptive Inorganic Chemistry, McGraw-Hill International Edition, 1994.
E BOOKS	
1.	http://www.freebookcentre.net/chemistry-books-download/A-text-book-of-inorganic-chemistry.html
2.	http://www.freebookcentre.net/chemistry-books-download/Introduction-to-Inorganic-chemistry.html
MOOC	
1.	https://swayam.gov.in/courses/249-inorganic-chemistry-ii
2.	https://www.mooc-list.com/course/inorganic-chemistry-saylororg

COURSE TITLE	SPECTROSCOPY - APPLICATIONS IN ORGANIC AND INORGANIC CHEMISTRY			CREDITS	3
Course Code	CYA2804	Course Category	CC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Understands the basic concepts of instrumentation in spectroscopy.	1,2
2.	Able to interpret the structural information and determine the structure of the organic compound.	1,2,3
3.	Learns the merits of various spectroscopic techniques, operating principles and develop the problem solving skills.	1,2
4.	Knowledge on concepts in Mossbauer spectroscopy and ESR spectroscopy help in structural elucidation of organic and inorganic compounds.	2,3,4

Prerequisites : Knowledge in fundamentals of chemistry at higher secondary level

MODULE 1 – UV VIS SPECTROSCOPY (9L)

Various electronic transitions (185-800 nm) − Beer-Lambert law − Effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. FieserWoodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

Suggested Reading: K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.

MODULE 2 – NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (9L)

Introduction to Nuclear Magnetic Resonance, Chemical shift, Mechanism of electron shielding and factors contributing to the magnitude of chemical shift, Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic complexes. Experimental technique(CW and FT). Stereochemical non-rigidity and fluxionality: Introduction, use of NMR in its detection, its presence in trigonal bipyramidal molecules(PF5), Systems with coordination number six ($Ti(acac)_2Cl_2$, $Ti(acac)_2Br_2$).

Suggested Reading: K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.

MODULE – 3 IR AND RAMAN SPECTROSCOPY (9L)

Infrared and Raman spectroscopy of simple inorganic molecules, predicting number of active modes of vibrations, analysis of representative spectra of metal complexes with various functional groups at the coordination sites; application of isotopic substitution, organic functional group identification through IR spectroscopy. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds.

Suggested Reading: K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.

MODULE – 4 : MOSSBAUER SPECTROSCOPY (9L)	
Mossebauer effect, recoilless emission and absorption, hyperfine interaction, chemical isomer shift, magnetic hyperfine and quadruple interaction and interpretation of spectra. Structure elucidation problems using the above spectroscopic techniques. **Suggested Reading:** Colin N. Banwell, Elaine M. McCash Edition: Paperback (4th), Mcgraw-Hill College, 2006.	
MODULE 5 – ESR SPECTROSCOPY (9L)	
Introduction, Similarities between ESR and NMR, Behaviour of a free electron in an external Magnetic Field, Basic Principle of an Electron Spin 30 Resonance Spectrometer, Presentation of the spectrum, Hyperfine coupling in Isotropic Systems (methyl, benzene and Naphthalene radicals). Factors affecting the magnitude of g-values. Zero field splitting and Kramer s Degeneracy, Line width in solid state ESR, Double resonance technique in e.s.r. (ENDOR) Experimental method. Applications of ESR to the following: 1. Bis-Salicylaldiimine - Copper II 2. $CuSiF6.6H_2O$ & $(NH_3)_5Co\text{-}O.Co(NH_3)_5$ **Suggested Reading:** Colin N. Banwell, Elaine M. McCash Edition: Paperback (4th), Mcgraw-Hill College, 2006.	
LAB / MINI PROJECT/FIELD WORK	
N/A	
TEXT BOOKS	
1.	K. V. Raman, R. Gopalan and P. S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.
2.	C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi, 2000.
3.	Colin N. Banwell, Elaine M. McCash Edition: Paperback (4th), Mcgraw-Hill College, 2006.
4.	N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.
E BOOKS	
1.	https://pubs.acs.org/doi/abs/10.1021/ed044pA552.2
MOOC	
1.	http://freevideolectures.com/Course/2306/Small-Molecule-Spectroscopy-and-Dynamics

COURSE TITLE	ORGANIC CHEMISTRY PRACTICAL			CREDITS	3
Course Code	CYA2831	Course Category	CP	L-T-P-S	0-0-6-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students will learn to analyze of mixtures and separation techniques	3,4
2.	The students will learn to conduct various types of organic reactions	3,4
3.	The students will learn to prepare various types of organic compounds.	4,5

Pre-requisites : Knowledge of Chemistry in undergraduate level.

LAB / MINI PROJECT/FIELD WORK

1. Analysis of two component and three component mixtures; separation and Characterization of compounds.
2. Preparations involving two or three stages comprising of the following processes.
   a) Nitration
   b) Halogenation
   c) Diazotization
   d) Rearrangement
   e) Hydrolysis
   f) Reduction
   g) Alkylation
   h) Oxidation
3. Preparations illustrating the following:
   a) Benzoin condensation
   b) Cannizaro reaction
   c) Perkin reaction
   d) Fries rearrangement
   e) Reimer-Tiemann reaction
   f) Sandmeyer reaction
4. Multistep synthesis of organic compounds, isolation, characterization of the Products by spectroscopic techniques.
5. Determination of melting point- boiling point
6. Purification and separation techniques- Recrystallisation, Distillation, Thin layer and column chromatography.
8. Identification and structural elucidation of simple organic compounds by spectral Analysis

TEXT BOOKS

1.	B.S.Fumiss. A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell,
2.	Vogel's Text book of Practical Organic Chemistry, 5th edition ELBS,

E BOOKS

	http://www.springer.com/gp/book/9780412282300

MOOC

1	https://www.mooc-list.com/course/organic-chemistry-i-saylororg

COURSE TITLE	PHOTOCHEMISTRY			CREDITS	3
Course Code	CYA2851	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students learn about the fundamentals of photochemistry.	1,2
2.	The students learn about the tools used in photochemistry and reactions.	2,3
3.	Students learn about the energy efficiency of photochemical reactions.	2,3

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – FUNDAMENTALS OF PHOTOCHEMISTRY (9 L)

Absorption - emission of radiation – photochemical laws - Electronic transitions – lifetimes – photo physical processes in electronically excited molecules - Jablonski Diagrams - intersystem crossing – fluorescence and structure – triplet states and phosphorescence emission – emission property and electronic configuration - photophysical kinetics of unimolecular processes – State diagrams – delayed fluorescence – bimolecular processes – kinetics of collisional quenching - Stern-Volmer equation - electron transfer - energy transfer – Molecular orbital view of excitation – The geometry of excited states

MODULE 2 – TOOLS AND TECHNIQUES (9L)

Experimental techniques –photochemical reactors – excitation sources - conditions for photolysis (solvents, type of vessels used, wavelength of excitation etc.) - Quantum yield – determination of quantum yields of reaction - Detection of intermediates - Techniques for study of transient species in photochemical reactions - flash photolysis – lasers in photochemical kinetics – measurement of emission characteristics – fluorescence, phosphorescence and chemiluminescence - radiation chemistry - primary processes - effects-dosimetry - pulse radiolysis.

MODULE 3 – INORGANIC PHOTOCHEMISTRY (9L)

Photochemistry of transition metal complexes – photo physical processes - types of energy states - photoredox reactions - photosubstitution reactions – aquation – anation or ligand exchange reactions - Photosensitisation reactions – photorearrangement reactions – geometrical isomerisations, racemization, linkage isomerisation and ligand rearrangement reactions – photoredox reactions - organometallic photochemistry - metal carbonyls.

MODULE 4 – ORGANIC PHOTOCHEMISTRY (9L)

Reactions of electronically excited ketones - Norrish Type I and Type II reactions – photoreduction – Paterno Buchi reaction - Photochemistry of α, β-unsaturated ketones - cyclohexadieneones - Reactions of olefins – photochemical oxidation reduction reactions -

Reaction of oxygen with olefins - Singlet oxygen - selected reactions –cyclo addition reactions – Woodward Hoffman rule of electrocylic reactions – Photo Diels - Alder reactions - Photo Fries reaction - Barton reaction - Di-pi-methane rearrangement – photochemistry of aromatic compounds – photochemical reaction between anthracene and carbon tetrachloride - chemiluminescence.	
MODULE 5 – PHOTOCHEMISTRY IN ENERGY CONVERSION (9L)	
Mutagenic effect of radiation – Photosynthesis - – photoelectrochemistry of excited state - redox reactions - formation of fuels - hydrogen production – semiconductor electrodes - chemically modified electrodes – solar energy conversion and storage - photo galvanic cells.	
LAB / MINI PROJECT/FIELD WORK	
NA	
TEXT BOOKS	
1.	Nicholas J Turro, Juan C. Scaiano, "Principles of Molecular Photochemistry: An Introduction, Macmillan Publishers limited, 2009.
2.	S.Sankararaman, "Pericyclic Reactions - A Textbook: Reactions, Applications and Theory", Wiley – VCH Verlag GmbH, Paperback edition, 2005.
3.	Griesbeck, Griesbeck G Griesbeck, Axel G Griesbeck, "Synthetic Organic Photochemistry, CRC Press, 2004.
4.	R.Ramamurthi, V.Ramamurthi and V.Ramamurthi, "Photochemistry", CRC Press, 1997.
E BOOKS	
1.	https://books.google.co.in/books?id=zQvd1hBjp
MOOC	
1	https://pubs.acs.org/doi/abs/10.1021/acs.jchemed.5b00118

COURSE TITLE	HOMOGENEOUS & HETEROGENEOUS CATALYSIS			CREDITS	3
Course Code	CYA2852	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn about the principles of catalysis	1,2
2.	Students learn about the surface and molecular scale catalysis	2,3
3.	Students learn characterization of catalysts and recent advancements.	2,3

Pre-requisites : Knowledge of chemistry in under graduate level.

MODULE 1 – PRINCIPLES OF HOMOGENEOUS & HETEROGENEOUS CATALYSIS (9 L)

Introduction – advantages - disadvantages of catalysts – acidity – basicity - catalyst preparation - kinetics and thermodynamics of catalyzed reactions - heat and mass transfer limitations - conversion and electivity - catalyst activation - deactivation and regeneration - Catalysis in the gas phase - catalysis in dilute aqueous solution- general and specific acid and base catalysis - catalysis in concentrated strong acid solution- catalysis by bases - stepwise and concerted reactions - catalysis by metal ions - catalysis by electron transfer.

MODULE 2 – CATALYSIS BY SURFACE (9L)

Surface structure – adsorption- CO oxidation on Pd - NH3 synthesis on Fe - Hydrocarbon conversion on Pt - alcohol dehydration on -Al_2O_3 - reactions of olefins on ZnO - catalysis by supported metals -catalysis by mixed metal oxides - catalysis by metal sulfides.

MODULE 3 – CATALYSIS IN MOLECULAR-SCALE CAVITIES (9L)

Structure of zeolites - families of zeolites -adsorption and diffusion in zeolites –cracking - reactions of olefins - catalysis by zeolites containing metal complexes and clusters -non zeolite molecular sieves - clays.

MODULE 4 – CHARACTERIZATION OF CATALYSTS (9L)

XPS, UPS, AES, SAM, EXAFS, XANES, XRD, IR, NMR, TPD etc-Modern methods of catalyst preparation - catalyst design including traditional and novel methods of preparation for oxides-supported metals - zeolites and heteropolyacids.

MODULE 5 – RECENT DEVELOPMENTS CATALYSIS INTERFACE (9L)

Phase transfer catalysis- catalysis by micelles- catalysis by enzymes- applications of homogeneous catalysis for fine and specialty chemicals synthesis - catalysis by enzymes - catalysis by polymers.

LAB / MINI PROJECT/FIELD WORK

NA

TEXT BOOKS

1.	Catalytic Chemistry, B. C. Gates, John Wiley & Sons, Inc. 1992.
2.	Principles and Practice of Heterogeneous Catalysis, J. M. Thomas and W.J. Thomas, VCH, 1997.
3.	Heterogeneous Catalysis in Industrial Practice, by C. N. Satterfield, McGraw Hill, 2nd Edition, 1991.
4.	Fundamentals of Industrial Catalytic Processes, RJ Farrauto, CH Bartholomew

E BOOKS

1.	https://www.kobo.com/us/en/ebook/catalysis-2

MOOC

1	https://www.mooc-list.com/university-entity/catalyst

COURSE TITLE	ORGANOMETALLIC CHEMISTRY FOR ORGANIC SYNTHESIS			CREDITS	3
Course Code	CYA2853	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn about the basics of organometallic compounds	1,2
2.	Students learn about metal carbonyl and palladium in systhesis	2,3
3.	Students learn about boranes, silanes and metallocelanes	2,3

Pre-requisites : Knowledge of chemistry in under graduate level.

MODULE 1 – FUNDAMENTAL CONCEPTS IN TRANSITION METAL CHEMISTRY FOR ORGANIC SYNTHETIC TRANSFORMATIONS (9 L)

Metal carbenes – synthesis – reactivity - analogy with ester groups for oxy carbenes - cycloaddition reactions of metal carbenes - synthesis of fused ring systems - Dotz reaction - mechanism of ring formation - application in targetted organic synthesis - Application of cobalt carbonyls in organic synthesis, Pauson Khand reaction and cyclopentenone synthesis, Vollhardt reaction.

MODULE 2 – METAL CARBONYLS IN ORGANIC SYNTHESIS (9L)

Pearson reaction - use of organoiron complexes for stereospecific synthesis of substituted cyclic compounds - Use of arene chromium tricarbonyl complexes in organic synthesis - the stereo effect of piano-stool structure - enhancement of arene electrophilicity and acidity of side chain - Chirality of arene chromium complexes and asymmetric synthesis.

MODULE 3 – PALLADIUM IN ORGANIC SYNTHESIS (9L)

Addition of organopalladium to unsaturated compounds - application to organic synthesis - stereochemical implications - Heck reaction - applications in synthesis.

MODULE 4 – ORGANOBORANES AND ORGANOSILANES IN ORGANIC SYNTHESIS (9L)

Hydroboration – reacations of organoboranes – enantioselecvitive synthesis of secondary alcohols from alkenes – reaction with α – bromoketones – diazo compounds - free radical reactions of organoboranes – protection of functional groups with organosilicon compounds –trimethylsilyl ethers – silyl enol ethers – α-silylcarbanions - β – silylcarbonyl compounds – trimethylsilyl iodide – trimethylsilyl triflate.

MODULE 5 – METALLOCENES (9L)

Metallocenes - Ziegler-Natta polymerization of alkenes with stereospecificity - Hydroformylation, Wacker process - oxo process – hydrogenation - oxidation - other catalytic processes.

TEXT BOOKS

1.	Stephen G. Davies, Organotransition Metal Chemistry, Application to Organic Synthesis, Pergamon Press, 1982.
2.	J. P. Collman, L. S. Hegedus, J. R. Norton, and R. G. Finke, Principles and Applications of Organotransition Metal Chemistry, University Science Books, 1988
3.	Barry Trost and Ian Fleming, (editors), Comprehensive Organic Synthesis, Pergamon. 1996.
4.	Wilkinson (Editor), Comprehensive Organometallic Chemistry, Pergamon, 1982

E BOOKS

1.	https://www.degruyter.com/view/product/9645

MOOC

1	https://www.class-central.com/tag/organometallic%20chemistry

COURSE TITLE	SYNTHETIC METHODOLOGY IN ORGANIC CHEMISTRY			CREDITS	3
Course Code	CYA2861	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn basic concepts of methodology of organic synthesis	1,2
2.	Students learn on different types of bond formation, coupling.	2,3
3.	Students learn about protecting methods of groups during synthesis	3,4

Pre-requisites : Knowledge of chemistry in under graduate level.

MODULE 1 – BASIC RETROSYNTHETIC ANALYSIS (9 L)

Terminology associated with, prostereoisomerism - homo, enantio, diastereo ligands and faces, - stereoselective synthesis.

MODULE 2 – NUCLEOPHILIC C-C BOND FORMING REACTIONS (9L)

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.

MODULE 3 – CHEMISTRY OF UMPOLUNG (9L)

Umpolung reagents, definition of umpolung, acyl anion equivalent, equivalents of ketene, $RCOCH_2^+$, $RCOCH_2CH_2CH_2^+$, $RCOCH_2CH_2CH_2^-$ etc

MODULE 4 – C-C BOND FORMATION (9L)

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**

MODULE 5 – PROTECTING GROUPS IN ORGANIC SYNTHESIS (9L)

Protecting groups, protection of hydroxyl, carboxyl, carbonyl, amino groups - Protection of carbon-carbon multiple bonds - Illustration of protection and deprotection in synthesis.

LAB / MINI PROJECT/FIELD WORK

NA

TEXT BOOKS

1. F. A. Carey and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 3rd ed, Plenum Press, 1990.
2. S. Warren, Designing Organic Synthesis, John Wiley, 1978.
3. S. G. Davies, Organotransition Metal Chemistry, Application to Organic Synthesis, Pergamon Press, 1982.
4. R. K. Mackie and D. M. Smith, Guidebook to Organic Synthesis, ELBS, 1982.

E BOOKS

1. http://www.cambridge.org/gb/academic/subjects/chemistry/organic-chemistry/modern-methods-organic-synthesis-4th-edition?format=PB

MOOC

1. https://www.mooc-list.com/tags/organic-reactions

COURSE TITLE	HETEROCYCLIC CHEMISTRY			CREDITS	3
Course Code	CYA2862	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	To learn about the basics of heterocyclic chemistry	1,2
2.	Students learn about 3,4,5 and 6 member hetrocyclic compounds.	2,3
3.	Students learn about applications of heterocyclic compounds	2,3

Pre-requisites : Knowledge of chemistry in under graduate level.

MODULE 1 – HETEROCCYCLIC COMPOUNDS - STRUCTURE AND NOMENCLATURE (9 L)

Structure of three, four, five, six and seven membered heterocycles - Oxirane – Thiirane – 2H-Azirine – 3 H – Diazirine - Oxaziridine – Aziridine - Diaziridine - Oxetane – Thietane - Azete - Azetidine - 1,2-Dioxitane - 1,2-Dithiete - 1,2-Diazetidine – 1,2-dihydro 1,2-diazete - Hantsch Widman nomenclature – replacement nomenclature – systematic nomenclature – examples.

MODULE 2 - THREE AND FOUR MEMBERED HETEROCYCLES (9L)

Aromaticity - reactivity - synthesis – reactions - Oxirane – Thiirane – 2H-Azirine – 3 H – Diazirine - Oxaziridine – Aziridine - Diaziridine - Oxetane – Thietane - Azete - Azetidine - 1,2-Dioxitane - 1,2-Dithiete - 1,2-Diazetidine – 1,2-dihydro1,2-diazete.

MODULE 3 – FIVE MEMBERED HETEROCYCLES (9L)

Sources – reactivity and orientation - electrophilic substitution - reactions of Furan – Thiophene – Pyrrole – oxazole – isooxazole- thiazole – isothiazole – oxazolidine – pyrrolidine – thiazolidine – imidazole – pyrazole – imidazolidine – tetrahydrofuran – tetrahydrothiophene– synthesis – furan, thiophene, pyrrole and oxazole only - fused ring systems - benzofuran – isobenzofuran – dibenzofuran –- benzothiopene.

MODULE 4 – SIX MEMBERED HETEROCYCLES (9L)

Sources – reactivity – electrophilic and nucleophilic substitutions – reactions - synthesis - pyridine - pyrimidines (cytosine and uracil only) and purines -adenine and guanine only – morpholine – piperazine – quinoline – isoquinoline - chromenes – flavones – isoflavones.

MODULE 5 – APPLICATIONS OF HETEROCYCLES (9L)

Natural products containing heterocycles - polymers – optical brighteners – in dye industry - pesticides – drug intermediates - antibiotics - antibacterial – antifungals- analgesics – antihypertensive.

LAB / MINI PROJECT/FIELD WORK

NA

TEXT BOOKS

1.	Acheson, RM. Título:Introduction to the chemistry of heterocyclic compounds, John Wiley & Sons;1976.
2.	David T Davies, Aromatic Heterocyclic Chemistry, OUP Oxford, 1992.
3.	E.J.Corey, Name Reactions in Heterocyclic Chemistry, Wiley, 2005.
4.	Alan R Kartritsky et al, Comprehensive Heterocyclic Chemistry III, Elsvlier, 2007.

E BOOKS

1.	https://www.amazon.in/Heterocyclic-Chemistry-John-Joule-ebook/dp/B00D42LJ8I

MOOC

1	http://nptel.ac.in/courses/104105034/

COURSE TITLE	POLYMER CHEMISTRY			CREDITS	3
Course Code	CYA2863	Course Category	CE	L-T-P-S	3-0-0-1
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-4			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn about the basic concepts of polymers	1,2
2.	Students learn about different types of polymerization reactions	1,2
3.	Students learn about molecular weight distribution of polymers.	2,3

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – BASIC CONCEPTS OF POLYMERS (9 L)

Basic concepts of polymers – classification of polymers – organic and inorganic polymers.- classification based on occurrence, end use, thermal properties and structure-Tacticity and its determination using ^{1}H NMR-Crystalline and amorphous polymers – Factors affecting crystallinity and crystallisability- Effect of crystallinity on properties- Glass transition temperature and its determination.- thermal transitions- dialatometer-variation of specific volume of polymers with temperature- Factors affecting glass transition temperature.

MODULE 2 – CHAIN POLYMERISATION (9L)

Kinetics and mechanism of free radical, cationic and anionic polymerization- Trommsdorff's effect – chain transfer reactions and constants – living polymers – Alfin catalysts — coordination polymerisation - Ziegler-Natta catalysts - iniferters -Atom transfer radical polymerization.

MODULE 3 – STEP GROWTH POLYMERSIATION (9L)

Kinetics of polycondensation reactions – copolymerization – co-polymer equation – copolymer compositions from ^{1}H-NMR, FT-IR, UV spectra and chemical methods –Monomer reactivity ratios- Mayo-Lewis and Fineman-Ross methods- significance of reactivity ratios-Sequence length–Metathetical, Group transfer, Electrochemical and Ring-opening polymerization.

MODULE 4 – POLYMERISATION TECHNIQUES (9L)

Polymerisation techniques– homogeneous and heterogeneous polymerization – bulk (liquid, gas and solid monomers), solution, suspension and emulsion polymerization – merits and demerits – interfacial and melt polycondensation.

MODULE 5 – MOLECULAR WEIGHT AND ITS DISTRIBUTION (9L)

Number, weight and viscosity average molecular weights of polymers– determination of constants in Mark Houwink's equation-Poly dispersity index and molecular weight distribution – Molecular weight determination by GPC and viscometry- Polymer dissolution - thermodynamics of polymer dissolution –solubility parameter – Fractionation of polymers-fractional precipitation and fractional dissolution methods.

TEXT BOOKS

1. V.R.Gowarikar, N.V.Viswanathan and Jayadev Sreedhar, Polymer Science, Wiley Eastern Limited, Madras (2006).
2. F.N.Billmayer, Text Book of polymer Science, 3rd Edn. John Wiley & Sons, New York (2002).

E BOOKS

1. https://bookboon.com/en/introduction-to-polymer-science-and-technology-ebook

MOOC

1. http://www.open.edu/openlearn/science-maths-technology/science/chemistry/introduction-polymers/content-section-0

COURSE TITLE	FERTILIZER TECHNOLOGY			CREDITS	2
Course Code	CYA2871	Course Category	AE	L-T-P-S	2-0-0-2
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-3			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn about basics of fertilizers	1,2
2.	Students learn about NPK fertilizers, preparation and uses	2,3
3.	Students learn about complex fertilizers.	2,3

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – AN OVERVIEW (6L)

Role of organic manures and chemical fertilizer, types of chemical fertilizer, growth of fertilizer in India; their location; energy consumption in various fertilizer processes; materials of various fertilizer processes; materials of consumption in fertilizer industry.

MODULE 2 – NITROGENOUS FERTILIZERS (6L)

Production of ammonia and nitric acid; nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

MODULE 3 – PHOSPHATIC FERTILIZERS (6L)

Processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

MODULE 4 – POTASSIC FERTILIZERS (6L)

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

MODULE 5 – COMPLEX AND NPK & MIXED FERTILIZERS (6L)

Methods of production nitrophosphates, urea, diammonium phosphate, mono-ammonium phosphate - Miscellaneous Fertilizers - Mixed fertilizers and granulated mixtures; biofertilizers, nutrients, secondary nutrients and micro nutrients.

TEXT BOOKS

1.	"Handbook of fertilizer technology", Association of India, New Delhi, 1977.
2.	Menon, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams, 2012.
3.	Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
4.	Fertilizer Manual, "United Nations Industrial Development Organisation", United Nations, New York, 1967.

E BOOKS

1.	https://www.amazon.in/Fertilizer-Technology-Management-Brahma-Mishra-ebook/dp/B071V3BNH2

MOOC

1	http://nptel.ac.in/courses/103107086/

COURSE TITLE	PHARMACEUTICAL CHEMISTRY			CREDITS	2
Course Code	CYA2872	Course Category	AE	L-T-P-S	2-0-0-2
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-3			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	The students learn about analgesics and antihistamines.	1,2
2.	Students learn about antibiotics, types and functions.	2,3
3.	Students learn about advanced medicines used for state-of-art treatment	2,3

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – ANALGESICS AND ANTIPYRETICS (6L)

Introduction to pharmaceutical chemistry analgesics - Narcotic analgesics – Morphine analogues and its modification – Codeine – synthetic narcotic analgesics – Pethidines and methodones – Narcotic antagonists – Nalorphine – Antipyretic analgesics – pyrazole – salicylic acid – p-aminophenol derivatives – aspirin and salol derivatives – barbiturates – benzodiazepines.

MODULE 2 – ANTIHISTAMINES AND ANTIMALARIALS (6L)

Antihistamines – mode of action of antihistamines – ethylene diamine, ethanolamine, propylamine – cyclizine – phenothazine – Antimalarials – Life cycle of plasmodium species – classification – quinine – 4-amino and 8-amino quinolines – pyrimidines, acridines.

MODULE 3 – ANTIBIOTICS (6L)

Antibiotics – Penicillin – Semisynthetic penicillin – Chloramphenicol – Streptomycin – Cephalosporin – antifungals – Nystatin – Griseofulvin – Sulphadrugs – Sulphathiazole – Sulphamerazine – Sulpha guanidine- Sulphanilamide – Sulphadiazine – Methanism of action – uses.

MODULE 4 – ANTIHYPERTINSICE AND HYPOTENSIVE DRUGS (6L)

Antihypertensive and hypotensive drugs – mechanism of lowering blood pressure – α –methyl dopa – Pargyline – Bertyline – Hydralazine – Propranolol – Antitubercular drugs – PAS- INH – Ethambutol, Rifampicin – Pyrazinamide, Antiarythmic agents.

MODULE 5 – ANTINEOPLASTIC DRUGS (6L)

Antineoplastic drugs – alkylating agents – nitrogen mustards – aziridines – sulphonic acid esters – 1,2 – epoxides – antimetabolites – folic acid and pyrimimide antagonists – vinca alkaloids, hormones- oral contraceptives.

TEXT BOOKS

1. Berger, “Medicinal Chemistry”, Wiley Interscience, New York, Vol. I and II, 1990.
2. Asutosh Kar, “Medicinal Chemistry”, Wiley Eastern Ltd., Chennai, 1992.
3. Bentley and Driver’s, “Text book of Pharmaceutical Chemistry”, revised by L.M.Artherden Oxford University Press, London, 1985.

E BOOKS

1. http://www.pharmpress.com/product/9780857110725/essentials-of-pharmaceutical-chemistry-ebook

MOOC

1. https://www.mooc-list.com/tags/medicinal-chemistry

COURSE TITLE	CHEMISTRY OF NANOMATERIALS			CREDITS	2
Course Code	CYA2873	Course Category	AE	L-T-P-S	2-0-0-2
CIA	40%			ESE	60%
LEARNING LEVEL	BTL-3			ASSESSMENT MODEL	TA

	COURSE OUTCOMES	PO
1.	Students learn about synthesis and properties of nanomaterials	1,2
2.	Students learn on different dimensions of nanomaterials.	2,3
3.	Students learn about the characterization techniques used.	3,4

Pre-requisites : Knowledge of Chemistry in undergraduate level.

MODULE 1 – INTRODUCTION (6 L)

Nanotechnology – scope and emerging trends - bottom-up and top-down approaches; chemistry of solid surfaces – surface energy – chemical potential of curved surfaces- stabilization of colloidal dispersions by electrostatic and steric interactions- different types of nano materials.

MODULE 2 – SYNTHESIS OF NANOMATERIALS (6L)

General methods of synthesis of zero-dimensional nano particles – homogeneous nucleation and heterogeneous nucleation- growth of nuclei and factors of importance- synthesis of metallic-semiconductor and metal oxide nano particles

MODULE 3 – PROPERTIES OF NANOMATERIALS (6L)

Nanotubes - carbon nanotubes – synthetic methods for single walled and multi walled nanotubes- physical properties- optical, mechanical, magnetic and electrical properties- quantum size effects- structural characterization by scanning electron microscopy-X-ray diffraction and Raman spectroscopy- Inorganic nanotubes – synthesis and properties

MODULE 4 – NANOMATERIALS (6L)

One-dimensional Nanowires and nanorods- two-dimensional thin films- nano composites and nano-structured polymers- nano catalysts- nano clusters – preparation and properties

MODULE 5 – CHARACTERIZATION OF NANOMATERIALS (6L)

Physical techniques for fabrication of nanostructures – photolithography, electron beam lithography and related techniques– nanolithography by scanning tunneling microscopy and atomic force microscopy- assembly of nano particles and nanowires- Applications of nano materials in electronic and optoelectronic devices.

LAB / MINI PROJECT/FIELD WORK

NA

TEXT BOOKS

1. G. Cao – Nanostructures and nanomaterials- Synthesis, properties and applications – Imperial College Press, 2004.
2. T.Pradeep, Nano, The Essentials, Mc Graw Hill, 2007.

E BOOKS

1. https://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php

MOOC

1. https://www.mooc-list.com/tags/nanotechnology