B.Sc. CHEMISTRY

CURRICULUM AND SYLLABUS
(*Choice Based Credit System*)
(2017-18 onwards)

DEPARTMENT OF CHEMISTRY

KALASALINGAM UNIVERSITY
(Kalasalingam Academy of Research and Education)
Anand Nagar, Krishnankoil-626 126
Virudhunagar District, Tamil Nadu

VISION OF THE DEPARTMENT

To be a centre of excellence of international repute in education and research in the field of chemistry and other related interdisciplinary sciences.

MISSION OF THE DEPARTMENT

To promote the advancement of science and technology in the broadest in chemistry in all of its branches and other related interdisciplinary areas through quality education, research and service missions that produce technically competent, socially committed technocrats and scientists.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	**Expertise in Chemistry**: Will be able to nurture the needs of industries/laboratories related to chemistry including pharmaceutical/analytical chemistry.
PEO2	**Professional Growth:** Will be able to demonstrate information literacy skills for acquiring knowledge of chemistry, as a chemist/researcher and also as a life-long learner.
PEO3	**Analytical Skills**: Will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

PROGRAMME OUTCOMES (POs)

PO1	The firm foundation in chemical principles and higher level of understanding in each of the chemistry sub-disciplines such as organic, inorganic, physical, and analytical as well as fundamental principles of biotechnology, mathematics and physics have been developed.
PO2	Developing the working knowledge of chemical instrumentation and laboratory techniques and be able to use of skills to design and conduct independent work.
PO3	An understanding of current ethical issues in chemistry and be able to apply ethical principles in industries / research laboratories.
PO4	Familiarity with the applications of computers in chemistry: Modelling and simulation of chemical phenomena.
PO5	Communicate results of work to chemists and non-chemists, including respect for the tradition of careful citation of prior contributions.

B.Sc. CHEMISTRY CURRICULUM

Semester	Course Code	Course	L	T	P	Credits	
						For Maths Students	For Non-Maths Students
I	BAE17R112/ BAE17R151	Tamil/ Hindi	3	0	0	3	3
	BAE17R107	Communicative English	2	0	0	2	2
	CHY17R121	Chemistry-I	4	0	4	6	6
	PHY17R141	Physics-I	4	0	4	6	6
	MAT17R141/ BIT17R141	Mathematics-I/ Biotechnology-I*	5 4	1 0	0 4	6	6
	Total		**18**	**1**	**8**	**23**	**23**
	***For Non-Maths, L -17; T-0; P-12**						
II	BAE17R111	English	3	0	0	3	3
	CHY17R103	Environmental Science	2	0	0	2	2
	CHY17R122	Chemistry-II	4	0	4	6	6
	PHY17R142	Physics-II	4	0	4	6	6
	MAT17R142/ BIT17R142	Mathematics-II/ Biotechnology-II*	5 4	1 0	0 4	6	6
		Total	**18**	**1**	**8**	**23**	**23**
	***For Non-Maths, L -17; T-0; P-12**						
III	CHY17R221	Chemistry-III	4	0	4	6	6
	PHY17R241	Physics-III	4	0	4	6	6
	MAT17R241/ BIT17R241	Mathematics-III / Biotechnology-III*	5 4	1 0	0 4	6	6
	CHY17RSXX	Skill Enhancement Course-I	2	0	0	2	2
		Total	**15**	**1**	**8**	**20**	**20**
	***For Non-Maths, L -14; T-0; P-12**						
IV	CHY17R222	Chemistry-IV	4	0	4	6	6
	PHY17R242	Physics-IV	4	0	4	6	6
	MAT17R242/ BIT17R242	Mathematics-IV/ Biotechnology-IV*	5 4	1 0	0 4	6	6
	CHY17RSXX	Skill Enhancement Course-II	2	0	0	2	2
		Total	**15**	**1**	**8**	**20**	**20**

Semester	Course Code	Course	L	T	P	Credits	
						For Maths Students	For Non-Maths Students
	**For Non-Maths, L -14; T-0; P-12*						
V	CHY17R3XX	Discipline Specific Elective-I	4	0	4	6	6
	CHY17R3XX	Discipline Specific Elective-II	4	0	4	6	6
	CHY17R3XX	Discipline Specific Elective-III	4	0	4	6	6
	CHY17RSXX	Skill Enhancement Course-III	2	0	0	2	2
	Total		**14**	**0**	**12**	**20**	**20**
VI	CHY17R3XX	Discipline Specific Elective-IV	4	0	4	6	6
	CHY17R3XX	Discipline Specific Elective-V	4	0	4	6	6
	CHY17R3XX/ CHY17R399	Discipline Specific Elective-VI/ Project (or) Dissertation	4	0	4	6	6
	CHY17RSXX	Skill Enhancement Course-IV	2	0	0	2	2
	Total		**14**	**0**	**12**	**20**	**20**

CORE PAPERS: CHEMISTRY I TO IV (INTEGRATED COURSES)

Semester	Course Code	Name of the Course
I	CHY17R121	Atomic Structure, Bonding and General Organic Chemistry
II	CHY17R122	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
III	CHY17R221	Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II
IV	CHY17R222	Coordination Chemistry, States of Matter and Chemical Kinetics

CORE PAPERS: PHYSICS I TO IV (INTEGRATED COURSES)

Semester	Course Code	Name of the Course
I	PHY17R141	Mechanics and Properties of Matter
II	PHY17R142	Optics and Electricity
III	PHY17R241	Thermodynamics, Electromagnetism and Modern Physics
IV	PHY17R242	Analog and Digital Electronics

CORE PAPERS: MATHEMATICS I TO IV

Semester	Course Code	Name of the Course
I	MAT17R141	Algebra and Calculus
II	MAT17R142	Analytical Geometry, Vector Calculus and Fourier Series
III	MAT17R241	Application of Differential Equation, Laplace Transform and Complex Variable
IV	MAT17R242	Group Theory, Probability and Interpolation

CORE PAPERS: BIOTECHNOLOGY I TO IV (INTEGRATED COURSES)

Semester	Course Code	Name of the Course
I	BIT17R141	Biochemistry and Metabolism
II	BIT17R142	Bioanalytical Techniques
III	BIT17R241	Cell Biology and Genetics
IV	BIT17R242	Industrial Microbiology

SKILL ENHANCEMENT COURSES (SEC) (ANY 4)

S.No.	Course Code	Name of the Course
1	CHY17RS01	IT Skills for Chemists
2	CHY17RS02	Basic Analytical Chemistry
3	CHY17RS03	Chemical Technology & Society
4	CHY17RS04	Chemoinformatics
5	CHY17RS05	Business Skills for Chemists
6	CHY17RS06	Intellectual Property Rights (IPR)
7	CHY17RS07	Analytical Clinical Biochemistry
8	CHY17RS08	Green Methods in Chemistry
9	CHY17RS09	Pharmaceutical Chemistry
10	CHY17RS10	Chemistry of Cosmetics and Perfumes
11	CHY17RS11	Pesticide Chemistry
12	CHY17RS12	Fuel Chemistry
13	CHY17RS13	Food Chemistry
14	CHY17RS14	Industrial Chemistry
15	CHY17RS15	Agricultural and Leather Chemistry

DISCIPLINE SPECIFIC ELECTIVE PAPERS (DSE) (ANY 6*)

S.No.	Course Code	Name of the Course
1	CHY17R321	Applications of Computers in Chemistry + Laboratory
2	CHY17R322	Analytical Methods in Chemistry + Laboratory
3	CHY17R323	Molecular Modeling & Drug Design + Laboratory
4	CHY17R324	Novel Inorganic Solids + Laboratory
5	CHY17R325	Polymer Chemistry + Laboratory
6	CHY17R326	Research Methodology for Chemistry + Tutorial
7	CHY17R327	Green Chemistry + Laboratory
8	CHY17R328	Industrial Chemicals and Environment + Laboratory
9	CHY17R329	Inorganic Materials of Industrial Importance + Laboratory
10	CHY17R330	Instrumental Methods of Chemical Analysis + Laboratory
11	CHY17R331	Quantum Chemistry, Spectroscopy and Photochemistry + Laboratory
12	CHY17R332	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy + Laboratory
13	CHY17R333	Molecules of Life + Laboratory
14	CHY17R334	Nanochemistry + Laboratory
15	CHY17R335	Material Science + Tutorial
16	CHY17R336	Applied Chemistry + Laboratory
17	CHY17R337	Organic Photochemistry and Pericyclic Reactions + Tutorial

(Any 5 if Project/Dissertation is availed*)**

NON-CGPA COURSES

Group	Course	Credit(s)	Remarks
I	NCC	3	One Course from among this Group is to be successfully completed before proceeding to II Year
	NSS	3	
	Sports	3	
II	Industrial/ R&D Lab Training (Two Weeks)	3	Two Courses from among this Group is to be successfully completed before proceeding to III Year
	Industrial/ R&D Lab Visit (3 Nos.)	3	
	Scientific Lecture (90 min.- 4 Nos.)	3	
	Certification Course (BEC, Tally, JAVA)	3	
	Workshop/ Conference Participation (5 Nos.)	3	
	Extra-Curricular Activities (Association & Club Activities: YRC, Nature Club, Fine Arts, Photography Club, Yoga etc.)	3	
	Short-Term Course/ Internship Course (2 Weeks)	3	
	Aptitude Proficiency Certification (Soft Skills Training)	3	
	Foreign Languages (French/ German /Japanese /Korean)	3	
Minimum Credit Requirement: 09			

CONSOLIDATED CREDITS

Semester	Credits
I Semester	23
II Semester	23
III Semester	20
IV Semester	20
V Semester	20
VI Semester	20
Total Credits	**126**
Non-CGPA	09
Grand Total	**135**

CHOICE BASED CREDIT SYSTEM
B.Sc. CHEMISTRY

SEMESTER I

BAE17R112	தமிழ் இலக்கிய வரலாறும் புதினமும்	L	T	P	C
		3	0	0	3

Pre-requisite: Exposure to Tamil language at the higher secondary course level
Course Category: Language **Course Type:** Theory

கூறு-1 9 Hours

தமிழ் மொழியின் பழமையும் சிறப்பும் –திராவிட மொழிக்குடும்பம்

தமிழ்நாடு-தமிழின் சிறப்புகள்

பழந்தமிழ் இலக்கண நூல்கள்-தொல்காப்பியம்,நன்னூல் முதலிய இலக்கண நூல்கள்-எழுத்து,சொல்,பொருள் அதிகாரங்கள்

கூறு-2 9 Hours

சங்க காலம்-மூன்று சங்கங்கள்-இலக்கியச் சான்றுகள்-கல்வெட்டுச் சான்றுகள்

இலக்கண,சங்க நூல்களின் சிறப்பு-பத்துப் பாட்டு-எட்டுத்தொகை-சங்கத் தமிழர் மாண்புகள்

கூறு-3 9 Hours

சங்கம் மருவிய காலம்-பதிணெண் கீழ்க்கணக்கு நூல்கள்-வகைகள்

காப்பிய இலக்கிய வரலாறு-ஐம்பெருங்காப்பயங்கள்-சிறு காப்பியங்கள்-காப்பியக்கூறுகள்

கூறு-4 9 Hours

புதினம்

தேடல்

கூறு-5 9 Hours

அடிப்படை இலக்கணம்

முதல்,சார்பு எழுத்துக்கள்,மொழி முதல்,இறுதி எழுத்துக்கள்,வல்லினம் மிகும் மிகா இடங்கள்

பாட நூல்:

1. தமிழ் இலக்கிய வரலாறு
   முனைவர் ச.வே.சுப்பிரமணியன்

மணிவாசகர் பதிப்பகம்

31,சிங்கர் தெரு,பாரி முனை,

சென்னை-600 108

2. நன்னூல்-எழுத்ததிகாரம்

முனைவர் சு.அழகேசன் உரை

சுதன் பதிப்பகம்

தூத்துக்குடி

3. தேடல்

பொன்னீலன்

ஒன்பதாம் பதிப்பு

நியூபுக் ஹவுஸ் வெளியீடு

சென்னை-98

BAE17R107	Communicative English	L	T	P	C
		2	0	0	2

Pre-requisite: Basic knowledge at the higher secondary course level

Course Category: Ability Enhancement Compulsory Course **Course Type:** Theory

Objective(s) To introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions.

Course Outcome(s)

CO1 Understand the types of Communication

CO2 Analyse the Verbal Communication and Non Verbal Communication

CO3 Practice dynamics of Professional presentations

CO4 Know how to translate the foreign language

CO5 Know how to write letters both personal and professional

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M		S		
CO2		L			L
CO3	S		M	M	S
CO4		S		S	
CO5	L	M	L		L

Unit - Introduction: **6 Hours**

Theory of Communication - Types and modes of Communication

Unit – II Language of Communication: **6 Hours**

Verbal and Non-verbal (Spoken and Written)-Personal, Social and Business - Barriers and Strategies-Intra Personal, Inter Personal and Group Communication

Unit – III Speaking Skills: **6 Hours**

Monologue - Dialogue - Group Discussion-Effective Communication/Mis-Communication - Interview - Public Speech

Unit – IV Reading and Understanding: **6 Hours**

CloZe Reading - Comprehension - Summary Paraphrasing - Analysis and Interpretation - Translation (from Indian language to English and vice-versa) Literary/Knowledge Texts

Unit – V Writing Skills: **6 Hours**

Documenting - Report Writing - Making notes - Letter Writing

Books Prescribed

1. *Language through Literature* (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brat Biswas
2. Fluency in English Part II Oxford University Press, 2006
3. Business English, Pearson, 2008.

CHY17R121	**Chemistry–I: Atomic Structure, Bonding, General Organic Chemistry**	**L**	**T**	**P**	**C**
		4	**0**	**4**	**6**
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) To acquire basic knowledge about atomic structure, bonding, molecular structure, organic, stereochemistry and preparation of hydrocarbons.

Course Outcome(s)

CO1 Understanding the atomic structure, basics of quantum chemistry and its applications.

CO2 Explaining theories of chemical bonding and molecular structure.

CO3 Gathering basic knowledge of organic chemistry.

CO4 Learning the basic principles of stereochemistry.

CO5 Illustrate the preparative methods of saturated and unsaturated hydrocarbons.

Mapping of Course Outcome(s):

CO/PO	**PO**				
	1	**2**	**3**	**4**	**5**
CO1	S	M		L	
CO2			S	M	
CO3	M	M			L
CO4			M		S

CO5	L	S		S	

Unit-I Atomic Structure **12 Hours**

Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Postulates of Quantum Mechanics-Time independent Schrodinger equation (derivation not required) and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Spin quantum number (*s*) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, Anomalous electronic configurations.

Unit- II Chemical Bonding and Molecular Structure **12 Hours**

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy. Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding:

VB Approach: Shapes of inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs. MO treatment of homonuclear and heteronuclear diatomic molecules viz., H_2, O_2, N_2, CO, NO and NO^+. Comparison of VB and MO approaches.

Unit- III Fundamentals of Organic Chemistry **12 Hours**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting *pK* values. Aromaticity: Benzenoids and Hückel's rule.

Unit- IV Stereochemistry **12 Hours**

Conformations: Ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms).

Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro; D and L; *cis – trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

Unit V Aliphatic Hydrocarbons **12 Hours**

Functional group approach for the following reactions (preparations and reactions) to

be studied in context to their structure.

Alkanes: *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis and, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: *Preparation:* Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions: cis*-addition (alk. $KMnO_4$) and *trans*-addition (bromine), Addition of HX (Markownikoff's and *anti*-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: *Preparation:* Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* Formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
8. Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
9. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
11. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

List of Experiments for Practical: **30 Hours**

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
6. Estimation of hydrogen peroxide.

Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements).
2. Separation of organic compounds based on solubility.
3. Separation of mixtures by Chromatography: Measurement of the R_f value in each case (combination of two compounds to be given)
    a) Identification and separation of the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid)

by paper chromatography.

b) Identification and separation of the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Orient-Longman, 1960.

PHY17R141	Mechanics and Properties of Matter	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Physics at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) This course focuses on the basic concepts of mechanics and their applications in solving various physical problems. Also it focuses on the analysis of the different properties of matter

Course Outcome(s)

CO1	Acquire fundamental knowledge in Newtonian mechanics.
CO2	Gain the knowledge of gravitational force between bodies including planets
CO3	Analyze the elastic properties of materials
CO4	Analyze the viscous properties of materials
CO5	Understand the concepts of surface tension and its implications.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	S		L	
CO2			S		L
CO3	M	M		S	
CO4			M		M
CO5	L	M		M	

Unit I: Mechanics **12 Hours**

Laws of impact – direct impact of spheres – expression for loss of kinetic energy during collision - moment of inertia – parallel & perpendicular axes theorem – proof – law of conservation of angular momentum – expression for rotational kinetic energy – torque - compound pendulum theory – period –torsional pendulum theory –moment of inertia of a disc – moment of inertia of a uniform rod , circular disc and solid sphere (proof).

Unit II: Gravitation **12 Hours**

Kepler's laws of motion – Newton's universal law of gravitation – Determination of G by Boy's method – inertial mass & gravitational mass – variation of g with altitude – latitude – depth , poles & equator – satellites – orbital velocity – escape velocity – relation.

Unit III: Elasticity **12 Hours**

Definition – stress – strain – three modulii of elasticity – units – dimensions – Hooke's law – definition – yield point – elastic limit – elastic fatigue – Poisson's ratio – definition – limiting values – relation between q , n , k and □-expression for bending moment – theory of uniform and non – uniform bending.

Unit IV: Viscosity & Fluid Motion **12 Hours**

Definition – units – dimension – stream lined motion & turbulent motion – definition – Poiseuilli's formula to determine □ (without correction for pressure head) – equation of continuity – Bernoulli's theorem – statement only – venturimeter – Ostwald's viscometer – motion of bodies in highly viscous media – definition – terminal velocity – Stoke's experiment with theory (dimension method).

Unit V: Surface Tension **12 Hours**

Definition – units – dimensions – surface energy definition – units – Excess pressure inside a spherical and cylindrical drop & bubble (synclastic system proof) – angle of contact – capillarity – ST determination by capillary rise - experiment to determine ST & IST by drop weight method – determination of ST of a liquid by Jaeger's method – variation of ST with temperature.

Text Books:

Mechanics & Properties of matter, Brijlal, N. Subrahmanyan, S. Chand & Co., 2002.

Reference Books:

1. Mechanics Berkeley Physics course, Charles Kittel, Tata McGraw-Hill, 2007
2. University Physics, Ronald Lane Reese, Thomson Brooks/Cole, 2003.
3. Mechanics, D.S. Mathur, S. Chand & Co., 2000.

***List of Experiments for Practical*:** **30 Hours**

1. Measurements of length (or diameter) using verniercaliper, screw gauge and travelling microscope.
2. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
3. To determine the Elastic Constants of a Wire by Searle's method.
4. Compound pendulum – g and k.
5. Non-uniform bending – Pin and Microscope.
6. Uniform bending – Optic lever.
7. Cantilever depression – scale and telescope.
8. Torsion Pendulum.
9. Surface tension – Capillary rise.
10. Experiment to determine coefficient of viscosity of low viscous liquid by capillary Flow Method (Poiseuille's method).

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted, 1985, Heinemann Educational Publishers.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

MAT17R141	Algebra and Calculus	L	T	P	C
		5	1	0	6

Pre-requisite: Basic knowledge of Mathematics at the higher secondary course level
Course Category: Program Core **Course Type:** Theory

Objective(s) To enable the students to acquire basic knowledge in Algebra, Calculus, and Trigonometry.

Course Outcome(s)

CO1 To understand the basic concepts of theory of equation and know the relation between roots and coefficients.
CO2 To learn about the nature of roots.
CO3 To know about the application of calculus.
CO4 To know the properties of definite integral and reduction formula.
CO5 To study about the Partial differentiation and Euler's theorem.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L	S		M	
CO2			M		L
CO3	M	L		S	
CO4			S		M
CO5	S	M		L	

Unit I: Relation between Roots and Coefficients of an Equation **15 Hours**

Theory of equations – An nth degree equation has exactly n roots – Relation between the roots and Coefficients-Reciprocal equations.

Unit II: Methods for finding Real Roots **15 Hours**

Finding the roots up to two decimals by Descarte's Rule – nature of roots – Descarte's Rule of signs-Newton's and Horner's Methods.

Unit III: Radius of Curvature **15 Hours**

Curvature-Radius of Curvature, Centre of curvature of Plane curves-Evolutes

Unit IV: Definite Integral **15 Hours**

Definite integrals, Reduction formulas for sinnx, cosnx, secnx, cotnx, cosecnx, and sinmx.cosnx and simple problems.

Unit V: Partial Differentiation and Euler's Theorem **15 Hours**

Partial Differentiation -Homogeneous functions and Euler's Theorem.

Text book:

1. S. Arumugam, Ancillary Mathematics, Paper I, New Gamma Publishing House, Reprint 2002.

2. S.Arumugam, A. Thangapandi Isaac, A. Somasundaram. Mathematics for Engineers, Scitech Publications Pvt. Limited, Chennai 2008.Unit 1: Text Book-1-Chapter-1(Sections 1.0-1.3)

Unit 2: Text Book-1-Chapter-1(Section 1.4, 1.5)

Unit 3: Text Book-1-Chapter-3(Section 3.5)

Unit 4: Text Book-1-Chapter-3(Section-3.5).

. Unit 5: Text Book-2-Chapter-4(Section-3.5).

BIT17R141	Biochemistry and Metabolism	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Biology at the higher secondary course level **Course Category:** Program Core **Course Type:** Integrated Course					

Objective(s) To understand the role of biochemistry and metabolism in living beings

Course Outcome(s)

CO1	Explain structure and classification of carbohydrate and its pathways
CO2	Describe different structures of proteins and amino acids and its metabolism
CO3	Explain the structure and biological functions of vitamins and its deficiency diseases
CO4	Describe various classifications and biological significance of lipids and fatty acids and its metabolisms
CO5	Describe the classification of enzymes and its kinetics

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		M	L	M	
CO2	M		S	M	S
CO3		S			L
CO4		L	M	S	
CO5	S		M		M

Unit I: Carbohydrates **12 Hours**

Structure and classification of monosaccharides (aldoses & ketoses), disaccharides and polysaccharides – Reducing and optical properties of sugars – biological importance of monosaccharides, oligosaccharides and polysaccharides: Storage and structural polysaccharides (glycogen, starch, cellulose, , insulin, chitin and glycosaminoglycans) – Reactions and energy balance in Glycolysis, Gluconeogenesis and TCA cycle –Glyoxylate cycle – Glucuronic acid cycle – Glycogen metabolism – Pentose phosphate.

Unit II: Amino Acids and Proteins **12 Hours**

Structureand classification of amino acids, essential, non–essential, unusual and non-protein – Peptide bond – stability and formation, primary secondary, tertiary and quaternary structure of protein – Denaturation (pH, temperature, chaotropic agents) – Amino acids degraded to Pyruvate, Oxaloacetate – Amino acids degraded to Acetyl-CoA, Succinyl-CoA – Metabolism of branched chain amino acids – Glucose alanine cycle, urea cycle

Unit III Vitamins **12 Hours**

Vitamins: fat soluble and water soluble vitamins; classification, structures and biological functions of fat soluble and water soluble vitamins and their deficiency.

Unit IV: Lipids and Fatty Acids **12 Hours**

Classification & biological significance of lipids & fatty acids – Simple, compound and derived lipids. Steroids and sterols: Cholesterol and bile acids. Fatty acids metabolism: Synthesis and β – oxidation, Ketone bodies.

Unit V: Enzymes **12 Hours**

Nomenclature and classification of enzymes - Holoenzyme, apoenzyme, co-factors, co-enzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes - Thermodynamics of catalysis, Energy of activation, Relation of ΔG and K_{eq} – Enzyme activity and specific activity – catalytic activity of enzymes - Reversible and irreversible activation of enzymes (pro-enzymes, phosphorylation)

List of Experiments for Practical: **30 Hours**

1. Preparation of buffer solutions
2. Qualitative analysis of lipids
3. Qualitative analysis of carbohydrates
4. Qualitative analysis of amino acids
5. Determination of reducing sugars by DNS method
6. Quantitative estimation of aminoacids by ninhydrin method
7. Estimation of proteins (Biuret method)
8. Lowry's method of protein estimation
9. Estimation of Saponification value of fats/oils.
10. Extraction and quantitative estimation of total lipids from food samples

References:

1. David, L., Nelson and Michael, M., Cox., Lehninger's - Principles of Biochemistry, Macmillan worth Publisher, USA, 3rd Edition, 2000

2. Voet, D., Voet, G., Biochemistry, John Wiley and Sons, Singapore, 3rd Edition.

SEMESTER II

BAE17R111	Poetry, Short Stories, Fiction, Grammar, Composition And Vocabulary	L	T	P	C
		3	0	0	3

Pre-requisite: Exposure to English language at the higher secondary course level
Course Category: Language **Course Type:** Theory

Objective(s) The course aims to help the students achieve fluency and accuracy in English.

Course Outcome(s)

CO1 To introduce World renowned poets to students.
CO2 To make them understand the nuances of Short stories.
CO3 To acquaint students with the writings of Nobel laurates.
CO4 To excel in Grammar.
CO5 To excel in Composition.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	L		S	
CO2	L		S		M
CO3	S	M		L	
CO4			M		L
CO5	S	M		L	

Unit – I – Poetry **9 Hours**

Nissim Ezekiel – Night of the scorpion
Robert Frost – Road Not Taken
Percy Bysshe Shelley – Ode to the West Wind

Unit – II – Short Stories **9 Hours**

Jesse Owens - My Greatest Olympic Prize
R.K.Narayan – An Astrologer's Day
Stephen Leacock – My Financial Career

Unit – III – Fiction **9 Hours**

Ernest Hemingway – The Old man and the Sea

Unit – IV – Grammar **9 Hours**

a) Tenses
b) Nouns – Countable and Uncountable
c) Kinds of Sentences

d) Articles
e) Prepositions

Unit – V – Composition and Vocabulary **9 Hours**

1. **Composition**
    a) Letter Writing (Formal and Informal)
    b) Curriculum Vitae
    c) Situational Conversation
2. **Vocabulary**

One Word Substitutes:

Alimony, amateur, amnesty, anaesthesia, anarchist, anatomy, anonymous, archive, atheist, autobiography, cannibal, carcinogen, cardiologist, carnivorous, centenarian, contemporary, connoisseur, cosmopolitan, crew, detective, (21 – 40) emigrant, epitaph, extempore, fauna, feminist, fleet, flora, forgery, gymnasium, gynaecologist, herbivorous, hypocrisy, incorrigible, kleptomania, lexicographer, manuscript, mercenary, misanthrope, mortuary, novice, (41 – 60) obituary, omniscient, ophthalmologist, optimist, omnipotent, orphan, panacea, parasite, pedestrian, pessimist, philanthropy philatelist, polygamy, posthumous, post-mortem, secular, somnambulist , theology, unanimous, utopia.

Books Prescribed:

1. Sadanand Kamalesh. & Punitha, Susheela. Spoken English: A Foundation Course, Part 2 Orient Black Swan, New Delhi, 2011
2. Taylor, Grant. English Conversational Practice, New Delhi. Tata McGraw-Hill, 1975.

CHY17R103	**Environmental Science**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Pre-requisite: Basic knowledge of Environmental Science at the secondary school level					
Course Category: Ability Enhancement Compulsory Course		**Course Type:** Theory			

Objective(s) Creating awareness among engineering students about the importance of environment, the effect of technology on the environment and ecological balance is the prime aim of the course.

Course Outcome(s)

CO1	To Know the importance of environmental studies and methods of conservation of natural resources.
CO2	Describe the structure and function of an ecosystem and explain the values and Conservation of bio-diversity.
CO3	Explain the sources, environmental effects and control measures of various types of pollutions.
CO4	Select the appropriate methods for waste management.
CO5	Recall social issues and legal provision and describe the necessities for environmental act.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L		S	
CO2	L		S		M
CO3	M	S		M	
CO4		M	M		L
CO5	S	M		L	

Unit-I: Natural Resources **6 Hours**

Definition, scope, and importance of environmental sciences -Need for public awareness- Natural resources: Forest resources, Water resources, Land resources, Mineral resources, and Energy resources - Role of an individual in conservation of natural resources.

Unit-II: Ecosystem and Biodiversity **6 Hours**

Concept of an ecosystem - Structure and function of an ecosystem - Food chains, food webs and ecological pyramids - Biodiversity - Definition, value of biodiversity- Hot spots of biodiversity - Threats to biodiversity - Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-III: Environmental Pollution **6 Hours**

Sources, consequences and control measures of Air pollution, Water pollution, Soil pollution, Thermal pollution and nuclear pollution. Environmental threats -, Acid rain, Climate change, Global warming (Greenhouse effect), Ozone layer depletion. Fireworks: current environmental issues.

Unit-IV: Management of Environmental Pollution **6 Hours**

Causes, effects, treatments methods and control measures of solid waste, municipal waste, biomedical waste - Waste minimization techniques - Cleaner technology-- Disaster management: floods, earthquake, cyclone, landslides and Tsunami.

Unit-V: Social Issues and the Environment **6 Hours**

Water conservation, rain water harvesting- Environmental impact assessment- Precautionary and polluters pay principle- environment protection act - air (prevention and control of pollution) act - water (prevention and control of pollution) act - Population explosion - Family Welfare Programmes - Environment and human health - Human Rights - Women and Child Welfare.

Text Books

1. Dhameja, S. K., Environmental Engineering and Management, S. K. Kataria and sons, New Delhi, 1st edition 2015.
2. Anubha Kaushik and Kaushik C.P., Environmental Science & Engineering" New Age international Publishers, New Delhi, 2010.

Reference Books

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., 2nd edition, 2004.
2. Erach Bharucha, Textbook for Environmental Studies, UGC, New Delhi, 2004.
3. Miller T.G. Jr., "Environmental Science", Wadsworth Publishing Co. USA, 2nd edition 2004.
4. Erach Bharucha, "The Biodiversity of India", Mapin publishing Pvt. Ltd., Ahmedabad India, 2002.
5. Trivedi R.K., "Handbook of Environmental Laws", Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro media, 2003.
6. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
7. Wager K.D., "Environmental Management", W.B. Saunders Co., Philadelphia, USA, 1998.
8. Sawyer C. N, McCarty P. L, and Parkin G. F., Chemistry for Environmental Engineering, McGraw-Hill, Inc., New York, 1994.

CHY17R122	Chemistry-II: Chemical Energetics, Equilibria & Functional Organic Chemistry-I	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To grasp the concepts of thermodynamics, thermochemistry, chemical equilibrium

Course Outcome(s)

CO1	Understanding the thermodynamic laws, principles of thermochemistry and chemical equilibrium
CO2	Learning the solubility of ionic compounds and their solution properties
CO3	Illustrate the preparative methods of simple aromatic compounds
CO4	Explaining the preparation and reaction mechanism of alkyl and aryl halides
CO5	Preparation and reaction chemistry aliphatic and aromatic phenols, ethers and carbonyl compounds

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		L		M	
CO2	M		L		S
CO3	L	S		M	
CO4			S		L
CO5	S	M		L	

Unit I - Chemical Energetics and Chemical Equilibria **12 Hours**

Laws of Thermodynamics. Important principles and definitions of thermochemistry. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics.

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG_o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.

Unit II -Ionic Equilibria **12 Hours**

Types of electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, *p*H scale, common ion effect. Salt hydrolysis-Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit III – Aromatic Hydrocarbons **12 Hours**

Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulfonation. Friedel-Craft's reaction (alkylation and acylation). Side chain oxidation of alkylbenzenes .

Unit IV - Alkyl and Aryl Halides **12 Hours**

Alkyl Halides: Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation. Williamson's ether synthesis: Elimination versus substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Unit V - Aliphatic and Aromatic Carbonyl Compounds, Alcohols, Phenols and Ethers **12 Hours**

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles.

Reactions: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

Alcohols, Phenols and Ethers (Up To 5 Carbons)

Alcohols: *Preparation:* Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation *Diols:* (Up To 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulfonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Reference Books:

1. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John

Wiley & Sons (2014).
2. Mcmurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
8. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
10. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
11. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

List of Experiments for Practical **30 Hours**

Physical Chemistry (*Thermochemistry*)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic Equilibria (*p*H measurements)

1. Measurement of *p*H of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using *p*H-meter.
2. Preparation of buffer solutions:
    a. Sodium acetate-acetic acid
    b. Ammonium chloride-ammonium hydroxide
3. Measurement of the *p*H of buffer solutions and comparison of the values with theoretical values.

Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
   Recrystallisation, determination of melting point and calculation of quantitative yield to be done.
    a) Bromination of Phenol/Aniline
    b) Benzoylation of amines/phenols
    c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

4 (a) Estimation of Aniline

(b) Estimation of Phenol.

Reference Books

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.Chand & Co.: New Delhi (2011).

PHY17R142	Optics and Electricity	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Physics at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) This course aims to give clear understanding of the basic concepts of optics and electricity

Course Outcome(s)

CO1 Acquire fundamental knowledge in Ray optics.
CO2 Gain the knowledge of different types of LASER and their applications
CO3 Understand the different components of fibre optic communication systems
CO4 Analyze the different properties of static charges
CO5 Apply the concepts of current electricity in studying different bridge circuits.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		L		S	
CO2	S		L		S
CO3	L	M		S	
CO4		M	S		L
CO5	M	S		L	

Unit I: Optics **12 Hours**

Dispersion-dispersive power – deviation without dispersion-achromatic combination of prisms-formula derivation-dispersion without deviation-formula derivation- direct vision spectroscope-chromatic aberration in lenses-derivation-achromatic combination of lenses-spherical aberration-explanation-Eyepieces Huygen & Ramsden- differences .

Unit II: Laser **12 Hours**

Stimulated emission- absorption –spontaneous emission –population inversion-optical pumping-working principles of LASER - Ruby LASER- uses - He-Ne laser –applications.

Unit III: Fibre Optics & Holography **12 Hours**

Introduction- propagation of light-optical fibres-NA-graded index fibres- advantages of optic fibres in communications-principles of Hologram.

Unit IV: Electrostatics **12 Hours**

Inverse square law-electric field-potential difference-proof of E = dv/dx - volt-definition of Gauss law-proof-applications-mechanical stress-soap bubble - equipotential surface-Capacity- principle of capacitor-spherical & cylindrical capacitor-parallel plate capacitor with & without dielectrics-combination of capacitors in series & in parallel-energy of a charged capacitor.

Unit V: Current Electricity **12 Hours**

Ohm's law-standard unit of current-definition of ampere-units of voltage & resistance - Kirchoff's I & II law-applications-Wheatstone's network-condition for balance-condition for sensitiveness-application to Wheatstone's bridge-principles of Carey Foster's bridge-theory-Potentiometer-measurement of current & resistance-calibration of low & high range voltmeter.

Text Books:

1. Optics, Brijlal&Subramaniam, S. Chand Publication, 2014.
2. Electricity and Magnetism R Murugesan, S. Chand & Co. 1995

Reference Books:

1. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity and Magnetism, J.H. Fewkes& J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

List of Experiments for Practical: **30 Hours**

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. To compare capacitances using De'Sauty's bridge.
3. To study the Characteristics of a Series RC Circuit.
4. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b)Quality Factor
5. To determine a Low Resistance by Carey Foster's Bridge.
6. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ2 – T Law.
7. To determine the Refractive Index of the Material of a given Prism using SodiumLight.
8. To determine Dispersive Power of the Material of a given Prism using Mercury Light
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the wavelength of Laser light using Diffraction of Single Slit.
11. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
12. To determine the particle size by using LASER

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.

MAT17R142	Analytical Geometry, Vector Calculus and Fourier Series	L	T	P	C
		5	1	0	6

Pre-requisite: Basic knowledge of Mathematics at the higher secondary course level
Course Category: Program Core **Course Type:** Theory

Objective(s) To enable the students to understand the concepts of Analytical geometry of three dimensions, Vector calculus, Interpolation and Fourier series.

Course Outcome(s)

CO1 Understand the basic concepts of Analytical geometry.
CO2 Learn about the topic co-planar lines and sphere.
CO3 Know about the topic of multiple integrals.
CO4 Understand the concepts of interpolation.
CO5 Understand the concepts of Fourier series.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		L		M	
CO2	L		L		M
CO3	S	M		L	
CO4		M	S		L
CO5	S	S		L	

Unit I: Analytical Geometry of Three Dimensions **15 Hours**

Direction cosines, direction ratios of a line- angle between two straight lines - plane - straight lines.

Unit II: Analytical Geometry of Three Dimensions **15 Hours**

Angle between a plane and a line – co-planar lines- shortest distance between lines- spere-Equations of sphere –section of a sphere by a plane-tanget plane.

Unit III: Multiple Integrals **15 Hours**

Double integration – Cartesian and polar coordinates – Change of order of integration – Change of variable between Cartesian and polar – Area as double integral – Triple integration in Cartesian, cylindrical and spherical polar coordinates – Volume as triple integral.

Unit IV: Vector Calculus **15 Hours**

Vector differential operators, Gradient, Divergence, curl and their simple properties - Directional derivatives-Soleniodal - Irrotational vectors.

Unit V: Fourier Series **15 Hours**

Fourier series-Trigonometric series-Even and odd functions- Half range Fourier series-

Text Books:

1. S. Arumugam, Ancillary Mathematics, Paper I, New Gamma Publications,2002
2. S.Arumugam, A.Thangapandi Isaac, A.Somasundaram-Scitech Publications, Pvt.Ltd, 2008.
3. S.Arumugam, Issac, Allied Mathematics, Paper-III, New Gamma Publications,Pvt.Ltd, 2007.

Unit1: Text Book-1(Chapter-V-Section-5.3)
Unit 2: Text Book-1(Chapter-VI-Section-6.2, Chapter-VIII-8.1-8.3)
Unit 3: Text Book-2(Chapter-VIII-Section-8.2-8.4)
Unit 4: Text Book-2(Chapter-IX-Section-9.2-9.4)
Unit 5: Text Book-3(Chapter-3).

BIT17R142	Bioanalytical Techniques	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Biology at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To understand and apply bioanalytical tools for academic and research purposes

Course Outcome(s)

CO1	Understand the principles and concept of different types of microscopy and live imaging
CO2	Explain principles and applications of different types of spectroscopy and NMR
CO3	Describe various separation principles of chromatography and its applications
CO4	n the principles and applications of different types electrophoresis and blotting techniques
CO5	Describe the theory and applications of radioactive materials

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		S		L	M
CO2	M	L	S		M
CO3	M		M		
CO4	L	S		M	
CO5	S	M		L	M

Unit I: Microscopy **12 Hours**

Microscopy techniques – Optical, phase contrast microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy, Confocal microscopy and live imaging techniques

Unit II: Spectroscopy **12 Hours**

Absorption and emission spectroscopy techniques: Beer Lambert's Law, Molar extinction coefficient and absorption maximum. Principle, instrumentation and application of colorimetry, UV-Vis, IR, Fluorescence, atomic absorption spectroscopy. Nuclear Magnetic Resonance: Principle and application – Electron Spin Resonance: Principle and application.

Unit III: Chromatography **12 Hours**

Basic Principle of chromatography – Partitioning, counter current distribution. Principle, instrumentation and application of Paper Chromatography, Thin Layer Chromatography, Gas Chromatography, ion-exchange – Gel Exclusion Chromatography – Affinity Chromatography – HPLC and RP-HPLC.

Unit IV: Electrophoresis **12 Hours**

Centrifugation – Principle, instrumentation and application of Ultracentrifugation. Introduction to electrophoresis – moving boundary and zonal electrophoresis – Starch-gel, polyacrylamide gel (Native and SDS PAGE) – Agarose Gel electrophoresis, Pulsed Field Gel Electrophoresis (PFGE) – immuno- electrophoresis, isoelectric focusing (IEF) – Denaturing gels for RNA, southern and northern Blotting

Unit V: Tracer techniques **12 Hours**

Radioactivity theory – Isotopes used for labelling proteins (^{3}H, ^{14}C, ^{35}S and ^{125}I) and nucleic acids (^{3}H and ^{32}P) – Applications of Phosphor-imaging and Fluorography – ^{14}C and ^{18}O to study photosynthesis – Hershey-Chase experiment (^{31}P and ^{32}S for viral replication study) – Meselson and Stahl experiment (^{14}N and ^{15}N labelling for DNA replication)

List of Experiments for Practical: **30 Hours**

1. Staining of bacterial cells – Gram staining
2. Estimation of nucleic acids
3. Estimation of proteins
4. Isolation of plasmid DNA from bacteria
5. Agarose gel electrophoresis
6. Separation of nucleic acid bases by paper chromatography.
7. Microscopy- Theoretical knowledge of Light and Electron microscope

References

1. The Cell: A Molecular Approach. 5th edition by G.M. Cooper and R.E. Hausman. ASM Press & Sunderland, Washington D.C.; Sinauer Associates, MA
2. The World of the Cell.7th edition by W.M. Becker, L.J. Kleinsmith, J. Hardin and G. P. Bertoni. Pearson Benjamin Cummings Publishing, San Francisco.
3. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. Himalaya Publishing House, Delhi
4. The Tools of Biochemistry, Cooper TG, John Wiley and Sons

SEMESTER III

CHY17R221	Chemistry-III: Solutions, Phase Equilibrium, Electrochemistry & Functional Group Organic Chemistry-II	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Integrated Course			

Objective(s) To learn the basic principles of phase equilibrium, Electrochemistry and functional Group Organic Chemistry

Course Outcome(s)

CO1 Understand the properties of ideal, non-ideal solutions and phase equilibrium

CO2 Basic concepts of electrochemistry and its applications

CO3 Explain the preparation and reaction of carboxylic acids and amines

CO4 Develop the synthesis of aminoacids, peptides and proteins

CO5 Summarize the classification and structure of carbohydrates

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L	L		S	
CO2		M	L		M
CO3	M			L	S
CO4		S	S		L
CO5	S		M	L	

Unit I Solutions and Phase Equilibria **12 Hours**

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations fromRaoult's law – non-ideal solutions. Distillation of solutions. Lever rule.Azeotropes.

Partial miscibility of liquids: Critical solution temperature. Immiscibility of liquids-Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system. Gibbs Phase Rule. Derivation of Clausius–Clapeyron equation and its importance in phase equilibria.

Phase diagrams of one-component systems (water) and two component systems involving eutectics (lead-silver, metal-organic compound system).

Unit II Electrochemistry **12 Hours**

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number. Ionic mobility. Applications of conductance measurements:

determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt.

Conductometric titrations (only acid-base).

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell.Nernst equation and its importance. Standard Hydrogen Electrode (SHE). Standard electrode potential. Electrochemical series.

Calculation of equilibrium constant from EMF data. Concentration cells with transferenceand without transference. Liquid junction potential and salt bridge.

*p*H determination using hydrogen electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Unit III Carboxylic acids, Amines and Diazonium Salts 12 Hours

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids (aliphatic and aromatic): *Preparation (*Acidic and Alkaline hydrolysis of esters) and *Reaction: (*Hell – Volhard - Zelinsky Reaction).

Carboxylic acid derivatives (aliphatic): *Preparation (*Acid chlorides, Anhydrides, Esters and Amides from acids) and their interconversion.

Reactions: Reformatsky Reaction, Perkin condensation.

Amines (Aliphatic and Aromatic):

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann versus Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines.

Reactions: conversion to benzene, phenol, dyes.

Unit IV Amino Acids, Peptides and Proteins: 12 Hours

Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: esterification of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation - Edman degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by *N*-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Unit V Carbohydrates: **12 Hours**

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
10. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.

List of Experiments for Practical **30 Hours**

Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

$I_{2(aq)} + I^-_{(aq)} \rightarrow I^{3-}_{(aq)}$

$Cu^{2+}_{(aq)} + xNH_{2(aq)} \rightarrow [Cu(NH_3)_x]^{2+}$

Phase Equilibria

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol-water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol-water system and determination of the critical solubility temperature.

Conductance

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Performing the following conductometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base

Potentiometry

Performing the following potentiometric titrations:

i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Potassium dichromate vs. Mohr's salt

Organic Chemistry

I. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.
II. 1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine.

4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a non-reducing sugar.

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

PHY17R241	Thermodynamics, Electromagnetism and Modern Physics	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Physics at the higher secondary course level

Course Category: Program Core **Course Type:** Integrated Course

Objective(s) The aim of this paper is to expose the students with the knowledge in Heat and thermodynamics and make them to understand the basics of electromagnetism and modern physics

Course Outcome(s)

CO1 Understand the basic concepts of thermal conductivity.

CO2 Apply the basic thermodynamic properties in thermal systems

CO3 Understand the concepts in electromagnetism

CO4 Understand the basics of X-rays and its applications

CO5 Learn the basic concepts of nuclear radioactivity

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	L		L	
CO2		S	L		M
CO3	L			M	S
CO4		M	M		L
CO5	S		M	L	

Unit I: Heat **12 Hours**

Conduction in solids: Thermal conduction - thermal conductivity of a good conductor - theory and determination - Forbe's method - thermal conductivity of a poor conductor - theory and determination - Lee's disc method - relation between thermal and electrical conductivities - Wiedmann-Franz law - practical applications of conduction of heat. Solar constant - temperature of the Sun - solar spectrum.

Unit II: Thermodynamics **12 Hours**

Statements of I and II law – Carnot's Engine- Carnot's cycle of operations- Calculation of efficiency- Carnot's theorem – statement and proof-Concept of entropy –

change of entropy in a reversible and irreversible cycle – change of entropy when ice is converted into steam Newton's law of cooling – theory – concepts of specific heat of liquids , solids and gases- Dulong and Petit's law – Einstein's theory – drawback – Debye theory.

Unit III: Electromagnetism **12 Hours**

Force on a current carrying conductor – Force between two parallel conductors in free space – definition of Ampere – Torque on a current carrying loop in a magnetic induction – Ballistic galvanometer – construction and theory - experiments to find C1/C2 & E1/E2 – Aperiodic galvanometer – construction - theory – experiment – figure of merit – difference between periodic and aperiodic galvanometer. Faraday's laws of electromagnetic induction – Lenz's law - definition of self induction, mutual induction – units – L of solenoid – mutual inductance between two coils.

Unit IV: Atomic physics and Laser **12 Hours**

X rays – Coolidge tube - shortest wavelength – Bragg's law and Bragg X ray spectrometer – X ray spectra – characteristic X ray spectrum – Mosley's law – explanation-derivation - Compton effect formula derivation - experimental verification. Lasers: Principle – Ruby lasers – He-Ne lasers – uses.

Unit V: Nuclear Physics **12 Hours**

Half-life and mean life of radioactive element – relation – derivation – radioactive equilibrium – secular equilibrium – radio-carbon dating – neutron – discovery – properties – transmutation by neutrons – betatron – construction and working – artificial radioactivity – radio-isotopes – uses (tracers in medicine and agriculture) – elementary particles.

Text Books:

1. Heat, Thermodynamics and Statistical Mechanics, Brijlal & Subramaniam, S. Chand Publication, 2012
2. Modern Physics, R. Murugesan, S. Chand Publications, 2003.

Reference Books:

1. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill.
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Fundamentals of Modern Physics, Duggal and Chhabra, ShobanlanNagin, Chand & Co., 1997.

List of Experiments for Practical: **30 Hours**

1. To determine the coefficient of thermal conductivity of copper by Searle'sApparatus.
2. To determine the coefficient of Thermal Conductivity of Cu by Angstrom'sMethod.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee's disc method.
4. To study the variation of thermoemf across two junctions of a thermocouple with temperature.
5. Specific heat of liquid – Newton's law of cooling
6. Determine the Latent Heat of Steam.
7. Determination of Rydberg constant using Microsoft excels.
8. Determination of e/m using Microsoft excels.
9. Study of absorption spectra of Iodine and determination of its wavelength using grating.
10. To determine the wavelength of LASER source.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, KitabMahal, New Delhi.
4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

MAT17R241	Application of Differential Equation, Laplace Transform and Complex Variable.	L	T	P	C
		5	1	0	6

Pre-requisite: Basic knowledge of Mathematics at the higher secondary course level

Course Category: Program Core **Course Type:** Theory

Objective(s) To enable the students to acquire basic knowledge in Differential equations and application of differential equations, Laplace Transforms and analytic functions.

Course Outcome(s)

CO1 Understand the basic concepts of differential equations

CO2 Learn about the topic application of differential equation

CO3 Know about the topic of Partial differential equations

CO4 Understand the concepts of Laplace transform

CO5 Understand the concepts of complex variables

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L		L	
CO2		S	L		M
CO3	M		M		
CO4		L		M	L
CO5	S		M	L	S

Unit I: Differential Equations **15 Hours**

Second order equations and constant coefficients- second order equations with right hand side in the forms x^n, e^{ax}, sin ax, cosax, e^{ax}sinbx, e^{ax}cosbx ,$e^{ax}x^n$ –Second order equations.

Unit II: Applications of Differential Equations **15 Hours**

Growth, decay and chemical reactions-Simple electric circuits – Planetary Motion.

Unit III: Partial Differential Equations **15 Hours**

Partial differential equations – Formation of partial differential equations – Lagrange's equation – some standard forms.

Unit IV: Laplace Transforms **15 Hours**

Laplace transform-Inverse Laplace transformation-Solution of differential equations using Laplace Transforms.

Unit V: Complex Variables **15 Hours**

Analytic function – C.R.Equations (without proof)-Bilinear Transformation-Cross Ratios.

Text Book:

S. Arumugam and Thangapandi, Issac, Ancillary Mathematics Paper III, New Gamma Publications, 2003.
Unit 1: Chapter 3-Sections 3.1 to 3.6
Unit 2: Chapter 7-Section 7.2, 7.6, 7.11
Unit 3: Chapter 6- Section 6.1, 6.2, 6.3, 6.4
Unit 4: Chapter 5- Section 5.1, 5.2.
Unit 5: Chapter 10- Section 10.2, 10.3, Chapter 9-Section 9.2, 9.3.

Reference Books:

1. Narayanan & Manickavasagam Pillai, Differential Equations, S.V. Publication – Reprint, 2003.
2. P.Durai Pandian, Lakshmi Durai Pandian& D. Muhilan, Complex Analysis, Emerald publishers, 1995.

BIT17R241	**Cell Biology and Genetics**	**L**	**T**	**P**	**C**
		4	**0**	**4**	**6**
Pre-requisite: Basic knowledge of Biology at the higher secondary course level **Course Category:** Program Core **Course Type:** Integrated Course					

Objective(s) To know about the basics of cell biology and genetics

Course Outcome(s)

CO1 Understand the structure and classification of cell and its organelles
CO2 Explain structure and functions of different organelles in cells
CO3 Describe cell reproduction and cell to cell communications
CO4 Explain Mendelian and Neo-Mendelian concept of genetics
CO5 Describe structure of nucleic acids, mutation and hybridization of genes

Mapping of Course Outcome(s):

CO/PO	**PO**				
	1	**2**	**3**	**4**	**5**
CO1		L		S	M
CO2	L	S	M		

CO3		M		L	S
CO4	M	S	M	M	M
CO5	S			S	M

Unit I: Cell Structure **12 Hours**

Overview of cell structure: Classification, structural aspects of prokaryotic and eukaryotic cells, cytosol, compartmentalization of eukaryotic cells, cell fractionation – Cell membrane: Chemical components of plasma membrane, organization and Fluid mosaic model, cell recognition and membrane transport.

Unit II: Cell organelles and its function **12 Hours**

Structure and function of cell organelles: Nucleus (including chromosome), mitochondria, endoplasmic reticulum, plastids, lysosomes, ribosomes, vacuoles and chloroplasts. Structure and function of microtubules, microfilaments, intermediate filaments – Golgi complex: Structure, biogenesis, functions and role in protein secretion.

Unit III: Cell growth and reproduction **12 Hours**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction – Reproduction of cell: Mitosis and Meiosis – Interphase and division phase – Cell growth: Normal and cancerous – Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Unit IV: Genetics **12 Hours**

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Unit V: Mutation and Hybridization **12 Hours**

Structure of purines, pyrimidines, nucleosides and nucleotides - formation and stability of phosphodiester bond – chemical structure of DNA, Chargaff's rule; types of RNA. Properties of nucleic acids – denaturation and renaturation. Degradation of purines and pyrimidines. Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents. Recombination of genes in a chromosome crossing over, Cytological basis of crossing over

List of experiments: **30 Hours**

1. Cell division in Onion root tip
2. Isolation of squamous epithelium
3. Isolation of polytene chromosomes from dipteran larvae
4. Cell fractionation - isolation of sub cellular organelles such as mitochondria, chloroplast etc.

5. Staining of blood cells
6. Isolation of genomic DNA from bacteria
7. Isolation of genomic DNA from plant cells
8. Isolation of genomic DNA from animal cells

References

1. Molecular Biology of the cell, 5th edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff. Publisher: Garland Science, New York , June 7th 2012.
2. Fundamental Molecular Biology, 1st edition, Lizabeth A. Allison. Publisher: Blackwell Publishers, January 2007.
3. Genetics: Ananlysis and Principles, 4th edition, Robert J. Booker. Publisher: Mcgraw-Hill, January 2011.

SEMESTER IV

CHY17R222	**Chemistry-IV: Coordination Chemistry, States of Matter & Chemical Kinetics**	**L**	**T**	**P**	**C**
		4	**0**	**4**	**6**
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) To acquire the knowledge of coordination compounds, states of matter and kinetics of chemical reactions.

Course Outcome(s)

CO1	Grasp the behavior of transition and inner transition elements
CO2	Understand the formation and stability of coordination complexes
CO3	Comprehensive knowledge of the kinetic theory of gases, ideal and real gas behavior
CO4	Explain the concepts of condensed states of matter
CO5	Interpret the theoretical and experimental methods of chemical kinetics

Mapping of Course Outcome(s):

CO/PO	**PO**				
	1	**2**	**3**	**4**	**5**
CO1	S	M		L	
CO2		S	L		M
CO3	M		S		
CO4		L		M	L
CO5	L		M	S	

Unit-I Transition Elements (3d series) **12 Hours**

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, and Cr.

Lanthanoids and actinoids: Electronic configuration, oxidation states, colour, magnetic properties, lanthanide contraction and its consequences, separation of lanthanides (ion exchange method only).

Unit-II Coordination Chemistry **12 Hours**

IUPAC system of nomenclature.

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.Drawbacks of VBT.

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion.

Unit-III Kinetic Theory of Gases 12 Hours

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. vander Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Unit IV – Condensed States of Matter 12 Hours

Liquids

Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on coefficient of viscosity of a liquid (qualitative treatment only).

Solids

Forms of solids: Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals (Schottky and Frenkel only). Glasses and liquid crystals.

Unit-V Chemical Kinetics 12 Hours

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning
4. India Pvt. Ltd., New Delhi (2009).
5. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
6. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

7. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
8. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
9. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
10. Rogers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.

List of Experiments for Practical **30 Hours**

Inorganic Chemistry

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:
Cations: NH^{4+}, Pb^{2+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}
Anions: CO_3^{2-}, S^{2-}, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-,SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-
(Spot tests should be carried out wherever feasible)

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Drawing calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimation of the concentration of the same in a given solution.
3. Determination of the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

Physical Chemistry

I. Viscosity measurement (use of organic solvents excluded).
   i. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
   ii. Studying of the variation of viscosity of an aqueous solution with concentration of solute.

II. Chemical Kinetics
   Studying of the kinetics of the following reactions.
      1. Initial rate method: Iodide-persulphate reaction
   Integrated rate method:
      b. Acid hydrolysis of Ethyl acetate with hydrochloric acid.
      c. Saponification of ethyl acetate.
      d. Comparison of the strengths of Acids by studying kinetics of hydrolysis of ethyl acetate

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

PHY17R242	Analog and Digital Electronics	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Physics at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) This course aims to give exposure to the students on basic analog and digital electronic components, devices and their applications

Course Outcome(s)

CO1 Understand the basic concepts of semiconductor diodes and their applications

CO2 Understand the basics of characteristics transistors and their applications in amplifiers and oscillators

CO3 Understand the binary number systems and analyze the functions of digital logic gates

CO4 Apply the concepts of digital electronic in performing arithmetic operations

CO5 Design the flip flops and registers using digital logic circuits

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L			M
CO2		S	L		
CO3	M			L	S
CO4		M	S	M	L
CO5	L		M	S	

Unit I: P-N junction diode, Rectifiers and Filters **12 Hours**

P-N Junction-Formation of depletion layer- Voltage-current characteristics-P-N Junction diode-Diode ratings -diode testing-The ideal diode-The real diode-Diode circuit with DC and AC voltage sources- Full wave rectifier-Full wave Bridge rectifier-Filters-LC Filter-The CLC and Pi Filter- Zener Diode-Voltage regulation.

Unit II: Transistors **12 Hours**

Transistor –Naming the transistor terminals-action-symbols-transistor as an amplifier-transistor connections (CB,CE,CC)-Characteristics (CE only)-voltage divide bias-Single stage transistor amplifier-Negative feedback-Oscillators-types of sinusoidal oscillations-oscillatory circuits-undamped oscillation from tank circuit-Explanation of Barkhausen criterion-Hartley oscillator.

Unit III: Number Systems and Logic Gates **12 Hours**

Number systems – binary – octal – hexadecimal – conversions – codes – gray – ASCII excess-3 codes – Gates – OR , NOT, AND – De-Morgan's theorem and proof – universal gates – Boolean laws – K –map simplifications – SOP – implementing the simplified equation.

Unit IV: Digital arithmetic **12 Hours**

Binary arithmetic – 1's complement, 2's complement – addition & subtraction (unsigned numbers only) – half adder – full adder – multiplexers – de multiplexers – decoders – encoders – BCD to decimal decoders- decimal to BCD encoder.

Unit V: Flip flops and Register **12 Hours**

Flip- flops – RS, D (Using NAND gates), JK Flip flop- JK master - slave - 4-bit shift register (serial in – serial out) – working with waveforms.

Text Books:

1. Basic Electronics: Solid State, B.L.Theraja, S.Chand& Co., 2001.
2. Digital Electronics and Applications, Malvino& Leach, McGraw Hill, 1975.

Reference Books:

1. Principles of electronics, V.K.Mehta & Shalu Mehta, S. Chand Publications, 8th Ed., 2003.
2. A Text Book of applied electronics, R.S. Sheda, S.Chand& Co., 2003.
3. A. P. Malvino, Electronic Principals, Glencoe, 1993.
4. Digital Electronics, Subrata Ghoshal, Cengage Learning, 2012.

List of Experiments for Practical: **30 Hours**

1. Hartley Oscillator
2. Full-Wave Rectifier with capacitance filter
3. Transistor Characteristics – CE mode
4. Phase-shift oscillator
5. Zener Regulated Power supply (with Bridge Rectifier)
6. Single-stage amplifier – discrete components
7. NAND, NOR as universal gates
8. Half adder and Full adder – Using NAND/NOR gates.
9. Half subtractor and full subtractor
10. RS, T Flip flops using NAND gates only
11. Verification of De Morgan's theorems

Reference Books:

1. A Text Book of Practical Physics by M.N.Srinivasan, S.Balasubramanian, R.Ranganathan - Sultan Chand & Sons, 2007
2. A Text Book of Practical Physics by Indu Prakash and Ramakrishna, Kitab Mahal Agencies
3. Practical Physics: S.R. Govinda Rajan, T. Murugaiyan S. Sundara Rajan, Rochouse & Sons.

MAT17R242	Group Theory, Probability and Interpolation	L	T	P	C
		5	1	0	6
Pre-requisite: Basic knowledge of Mathematics at the higher secondary course level **Course Category:** Program Core **Course Type:** Theory					

Objective(s) To enable the students to acquire basic knowledge in Arithmetic calculations in solving real world problems

Course Outcome(s)

CO1 To understand the basic concepts of set theory and functions
CO2 To learn about group theory
CO3 To know about the topic of probability
CO4 To understand the concepts of interpolation
CO5 To understand the concepts of trigonometry

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	L			M
CO2		M	L		
CO3	M			L	S
CO4		S	S	S	L
CO5	L		S	S	

Unit I: Set Theory and Functions **15 Hours**

Concepts of sets – Operation on sets –Cartesian product of sets-Relations and equivalence relations – Partial Order-Functions-Binary Operation.

Unit II: Group Theory **15 Hours**

Group-Equivalent Definitions of a group - Elementary properties of group - Permutation group -subgroups-Lagrange's Theorem-Cyclic groups.

Unit III: Probability **15 Hours**

Probability-Axiom of Probability-Conditional Probability –Independents events – Bayes Theorem (without Proof) and connected Problems.

Unit IV: Interpolation **15 Hours**

Numerical Methods-Interpolation, Lagrange's and Newton's methods.

Unit V: Trigonometry **15 Hours**

Trigonometry-Expansions, Hyperbolic functions, Logarithms of complex numbers.

Text Books:

1. T.K.Manicavasagam Pillai and Narayanan, Numerical Analysis – TKM and Narayanan, S.Vishwanathan publications and printers, New Edition,1994.

2. Modern Algebra-S.Arumugam and A. Thangapandi Isaac, Scitech Publications Pvt. Limited, Chennai 2014.
3. Probability Statistics and Random Process, T.Veerarajan, Tata Mcgraw Hill Private limited, Delhi, Third Edition, 2009.
4. S. Arumugam, Ancillary Mathematics, Paper I, New Gamma Publishing House, Reprint 2002

Unit I: Text Book-2(Chapter-IV-Sections 1.1-1.6, 1.8, 2.1-2.5).
Unit II: Text Book-2(Chapter-III– Sections 3.1 -3.6).
Unit III: Text Book-3(Chapter-V- Section1.2, 1.4, 1.5, 1.11)
Unit IV: Text Book-1(Chapter- V- Section 1.1 to 1.9)
Unit V: Text Book-4(Chapter IV, Chapter-V).

Reference Book:

Calculus of Finite Differences and Numerical Analysis by R. Gupta – Malik, Krishna Prakashan Mandir, Meerut.

BIT17R242	Industrial Microbiology	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Biology at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To understand the underlying principles and applications of industrial microbiology

Course Outcome(s)

CO1 Understand the general concepts of different types of microbes
CO2 Explain structure and functions of bio-reactors and its industrial applications
CO3 Describe down-stream processing of industrial applications
CO4 Explain microorganism involved in industrial fermentation
CO5 Describe bio-mass and fuel generation using microbes

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L	L		M
CO2		M		L	S
CO3	L		S	M	
CO4			M	S	
CO5	M	S		L	M

Unit I: Introduction to Industrial Microbiology **12 Hours**

General concepts of Industrial microbiology – Study of industrially important microorganisms – Primary and secondary screening techniques – Strain development methods – Methods of maintaining culture in aseptic & sterile environment: Inoculate and preserve – Fermentation: Definition and various types of fermentation processes (Solid state, liquid state, batch, fed-batch and continuous)

Unit II: Bio-Reactors and Fermentation Parameters **12 Hours**

Industrial fermentations – Bio-reactor: Components and Types of bio-reactors – O_2 transfer - Scale-up, Foam and antifoam – Neutonian and non-neutonian fluids – Recovery and purification of intracellular and extracellular products – Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit III: Down-Stream Processing **12 Hours**

Cell disruption – Filtration and centrifugation – Solvent extraction – Precipitation – Lyophilization and spray drying.

Unit IV: Micro-Organisms involved Industrial Fermentation **12 Hours**

Microbial production of Wine and ethanol – Organic acid: Citric acid and Lactic acid – Antibiotics: Penicillin and Streptomycin – Vitamin: Vitamin B12 – Enzymes: Amylase (α and β) and lipase – Amino acid: Lysine

Unit V: Bio-Mass and Fuel Generation using Microbes **12 Hours**

Sources of biomass – Ethanol and methane from bio-mass – Microbes in petroleum recovery – H_2 gas from BGA – Photosynthesis – Pharmaceutically valuable microalgae

List of Experiments: **30 Hours**

1. Detection of bacteria in milk by SPC - Dye reduction test Detection of number of bacteria in milk
2. Citric acid production, its recovery and purification (lab scale)
3. Preparation of Baker's Yeast from molasses
4. Litmus mil reaction
5. Isolation of lactobacilli and staphylococcus from curd
6. Water analysis by MPN technique
7. Study different parts of fermenter
8. Microbial fermentations for the production and estimation of alcohol

References:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition, Wiley – Blackwell.
3. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

SKILL ENHANCEMENT COURSES

CHY17RS01	IT Skills for Chemists	L	T	P	C
		2	0	0	2

Pre-requisite: Exposure to Computer Science and Mathematical principles at the elementary course level

Course Category: Program Core **Course Type:** Theory

Objectives To acquire the knowledge of the information technology tools necessary for a blooming chemist.

Course Outcomes

CO1 Able to apply the methods of plotting graphs Uncertainty, techniques and error.

CO2 Use the Algebraic operations, Differential calculus and Numerical integration in

chemistry.

CO3 Understand the BASIC Computer programming.

CO4 Know to handle numeric data.

CO5 Able to apply Statistical analysis in chemistry.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	M			M
CO2		M	M		
CO3	M			L	M
CO4		M	S	S	L
CO5	L		S	S	

Unit I – Mathematical Principles for Chemists **6 Hours**

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

Unit II: Algebra and Calculus **6 Hours**

Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms).Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

Unit III - Computer Programming: **6 Hours**

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and ommands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

Unit IV- Hands-on Introductory writing activities: **6 Hours**

Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.

Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

Unit V - Numerical Modelling: **6 Hours**

Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The *t* test. The *F* test.

Presentation: Presentation graphics

Reference Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry, University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry, 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book, Oxford University Press (1996).
4. Yates, P. Chemical calculations, 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*, 6th Ed., Freeman (2007) Chapters 3-5.
6. Levier. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001), 487 pages.
7. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
8. Venit, S.M. Programming in BASIC: Problem solving with structure and style, Jaico Publishing House: Delhi (1996).

CHY17RS02	Basic Analytical Chemistry	L	T	P	C
		2	0	0	2

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level

Course Category: Program Core **Course Type:** Theory

Objectives To familiarize the students with the concept and methods of analytical techniques for soil, water and food.

Course Outcomes

CO1 Able to analyze soil.

CO2 Know the water analysis and quality of food products.

CO3 Able to apply various chromatographic techniques.
CO4 Know the chemistry of cosmetics.
CO5 Able to handle the possible analytical instruments.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	M	L			S
CO2		S	M	L	
CO3	S		L		M
CO4		M		S	L
CO5	L		S	M	

Unit I - Introduction: 6 Hours

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of *p*H of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Unit II - Analysis of water: 6 Hours

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Unit III - Chromatography: 6 Hours

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Unit IV - Analysis of cosmetics: 6 Hours

Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in traps cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

Unit V - Suggested Instrumental demonstrations: 6 Hours

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Steptoe, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

CHY17RS03	Chemical Technology and Society	L	T	P	C
		2	0	0	2

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Theory

Objectives Train the students on separation techniques, understanding the chemistry of up scaling methods and biomass utilization.

Course Outcomes

CO1 Able to perform extraction, leaching, adsorption and adsorption methods.
CO2 Able to use lab equipments.
CO3 To understand the Scaling up operations and clean technology
CO4 To create knowledge about societal issues on chemical industry.
CO5 To know about Biomass conversion methods.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		L		S	M

CO2		M	S	L	
CO3	M		S		L
CO4		S			S
CO5	L		S	M	

Unit I – Principles of Chemical Technology **6 Hours**

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption.

Unit II – Equipments and Machineries for Chemical Processing **6 Hours**

An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators.

Unit III-Scaling-up Techniques **6 Hours**

Scaling up operations in chemical industry. Introduction to clean technology.

Unit IV-Society **6 Hours**

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants);

Unit –V Energy Sources **6 Hours**

Energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversion from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Book:

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for Changing Times* 13th Ed.

CHY17RS04	**Chemoinformatics**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives This course will introduce the principles of chemoinformatics to represent molecules and chemical reactions, spectroscopic applications and drug design.

Course Outcomes

CO1	Understand the basic of chemoinformatics.
CO2	Represent molecules and chemical reactions.
CO3	Able to search chemical structures.
CO4	Perform Structure-Spectra correlations.
CO5	To apply Chemoinformatics in Drug Design.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1		L		M	M
CO2		M	M	L	
CO3	M		S		M
CO4		S			S
CO5	M		S	M	

Unit I - Introduction to Chemoinformatics: 6 Hours

History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.

Unit II - Representation of molecules and chemical reactions: 6 Hours

Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Mol Files and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Unit III - Searching chemical structures: 6 Hours

Full structure search, substructure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Unit IV - Applications: 6 Hours

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design.

Unit V – Drug design: 6 Hours

Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Hands-on Exercises

Reference Books:

1. Andrew R. Leach & Valerie, J. Gillet (2007), *An introduction to Chemoinformatics,* Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book.* Wiley-VCH.
3. Gupta, S. P. (2011) QSAR & Molecular Modeling. Anamaya Pub.: New Delhi.

CHY17RS05	Business Skills for Chemists	L	T	P	C
		2	0	0	2

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Theory

Objectives To create knowledge about business, involving chemistry and intelligent property, patents.

Course Outcomes

CO1 Understand the basics of business.
CO2 To understand the relation between Chemistry and industries
CO3 To know about the global economic status in relation with chemistry
CO4 Understand financial aspects of business.
CO5 Getting awareness of intellectual property and patents.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L			M
CO2		M	L	S	
CO3	M		S		L
CO4		S		M	L
CO5	L		M	S	

Unit-I Business Basics **6 Hours**

Key business concepts: Business plans, market need, project management and routes to market.

Unit-II - Chemistry in Industry **6 Hours**

Current challenges and opportunities for the chemistry-using industries

Unit-II - Chemistry and Economy **6 Hours**

Role of chemistry in India and global economy

Unit IV - Making Money **6 Hours**

Financial aspects of business with case studies

Unit V: Intellectual Property **6 Hours**

Concept of intellectual property, patents.

Reference

www.rsc.org

CHY17RS06	Intellectual Property Rights (IPR)	L	T	P	C
		2	0	0	2
Pre-requisite: Nil **Course Category:** Program Core				**Course Type:** Theory	

Objectives This course will acquire knowledge about Intellectual Property, trademarks, copy rights, patents, different International agreements IP Infringement issue and enforcement.

Course Outcomes

CO1 Remember the ideas of intellectual property rights.
CO2 Understand about the patents.
CO3 To analyze about the features of industrial design
CO4 To know the trade agreements
CO5 To understand the legal aspects of intellectual properties

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	M			M
CO2		M	L	L	
CO3	M		S		L
CO4		S		M	L
CO5	L		M	S	

Unit I - Introduction to Intellectual Property: **6 Hours**

Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights

Introduction, How to obtain, Differences from Patents.

Trade Marks

Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.

Differences from Designs.

Unit II – Patents **6 Hours**

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Unit III - Industrial Designs **6 Hours**

Definition, How to obtain, features, International design registration.

Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Unit IV - Different International Agreements **6 Hours**

(a) Word Trade Organization (WTO):

i. General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
ii. General Agreement on Trade related Services (GATS)
iii. Madrid Protocol
iv. Berne Convention
v. Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

Unit V - IP Infringement Issue and Enforcement **6 Hours**

Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Reference Books:

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru & M.B. Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Michael H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.

CHY17RS07	Analytical Clinical Biochemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Biology at the secondary school level					
Course Category: Program Core		**Course Type:** Theory			

Objectives To understand the chemistry of proteins, carbohydrates, lipids, DNA & RNA, blood and urine analysis.

Course Outcomes

CO1 To explain the carbohydrate chemistry
CO2 Understand the biochemistry of proteins
CO3 Understand the biochemistry of lipids
CO4 Know DNA & RNA and their functions.
CO5 Ability to perform urine and blood analysis.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5

CO1	S	L		S	M
CO2		M	L	L	
CO3	M		S		L
CO4		S		M	
CO5	L		M		S

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Unit I: Review of concepts studied in the core course: 6 Hours

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

Isolation and characterization of polysaccharides.

Unit II - Proteins: 6 Hours

Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins. Enzymes: Nomenclature, Characteristics (mention of Ribozymes), and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Unit III - Lipids: 6 Hours

Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.Lipoproteins.

Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Unit IV – DNA & RNA 6 Hours

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Unit V - Biochemistry of Disease: A Diagnostic Approach by Blood/ Urine Analysis 6 Hours

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

List of Experiments for Practical: **15 Hours**

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.

3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

1. T.G. Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
7. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
8. Mikes, O. Laboratory Handbook of Chromatographic & Allied Methods, Elles Horwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

CHY17RS08	Green Methods in Chemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives To familiarize the students with the concept and principles of green chemistry and green laboratory techniques.

Course Outcomes

CO1 Able to understand the theory of green chemistry
CO2 Understand the principles of Green Chemistry
CO3 Knowledge about green chemical applications
CO4 Environmental implications of Green Chemistry
CO5 To understand apply Green Chemistry procedures for real-world problems

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S	L			M
CO2		M	L	S	
CO3	L		S		M
CO4		S		M	
CO5	M		M		S

Unit I - Evolution of Green Chemistry **6 Hours**

Theory and Hand-on Experiments: Introduction: Definitions of Green Chemistry

Unit II – Principles of Green Chemistry **6 Hours**

Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents

Unit III – Applications of Green Chemistry **6 Hours**

Green Chemistry and catalysis and alternative sources of energy,

Unit IV – Green Chemistry and Environment **6 Hours**

Green energy and sustainability

Unit V – Green Processes and Procedures **6 Hours**

The following Real World Cases in Green Chemistry should be discussed:

1. Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
2. Designing of environmentally safe marine antifoulant.
3. Rightfit pigment: Synthetic azopigments to replace toxic organic and inorganic pigments.
4. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

List of Experiments for Practica:l **15 Hours**

1. Preparation and characterization of biodiesel from vegetable oil.
2. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice.
3. Mechanochemical solvent free synthesis of azomethine.
4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Reference Books:

1. Anastas, P.T. & Warner, J.K. *Green Chemistry-Theory and Practical*, Oxford University Press (1998).
2. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
3. Cann, M.C. & Connelly, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
4. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
5. Sharma, R.K.; Sidhwani, I.T. & Chaudhuri, M.K. *Green Chemistry Experiments: A monograph*, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
6. Lancaster, M. *Green Chemistry: An introductory text* RSC publishing, 2nd Edition.
7. Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malvika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A Social Awareness Project", Delhi University Journal of Undergraduate Research and Innovation, 1(1): 2015.

CHY17RS09	Pharmaceutical Chemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives To make awareness among the students on pharmaceutical chemicals and their medicinal applications.

Course Outcomes

CO1 Understand the chemistry of drug molecules and drug design
CO2 Know about synthesis techniques of drugs
CO3 Understand the various classes of drugs
CO4 Study about cardiovascular and CNS depressants
CO5 Ability to apply fermentation techniques.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		L	S		M
CO2		M	L	S	
CO3	L		M		L
CO4	L	S		M	
CO5	M		L		S

Unit I - Drugs & Pharmaceuticals **6 Hours**

Drug discovery, design and development; Basic Retrosynthetic approach.

Unit II – Synthetic Procedures of Drugs **6 Hours**

Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti inflammatory agents (Aspirin, paracetamol, ibuprofen);

Unit III – Antibiotics, Antibacterials, Antifungals and Antiviral Drugs **6 Hours**

Antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphamethoxazole, Sulphacetamide, Trimethoprim); Antiviral agents (Acyclovir).

Unit IV – CNS Agents and Cardiovascular Drugs **6 Hours**

Central Nervous System agents (Phenobarbital, Diazepam)**,** Cardiovascular (Glyceryl trinitrate), anti leprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Unit V – Fermentation and Synthesis of Drugs **6 Hours**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

List of Experiments for Practical: **15 Hours**

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

1. G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi.

CHY17RS10	**Chemistry of Cosmetics and Perfumes**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives To train the students for the preparation of various cosmetics & perfumes.

Course Outcomes

CO1	Able to know various hair dyes and applications
CO2	Ability to prepare cosmetics
CO3	Understand flavouring agents
CO4	Know about essential oils
CO5	Understand the chemistry behind perfumeries

Mapping of Course Outcome(s):

CO/PO	**PO**				
	1	**2**	**3**	**4**	**5**
CO1	L		S		
CO2		M	L		S
CO3	S		M		L
CO4				M	
CO5	M	S	L		S

Unit I – Hair colourants and Lotions **6 Hours**

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions.

Unit II – Cosmetics **6 Hours**

Face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams).

Unit III – Flavouring Agents **6 Hours**

Antiperspirants and artificial flavours

Unit IV- Essential Oils **6 Hours**

Essential oils and their importance in cosmetic industries with reference to Eugenol,

Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol.

Unit V – Perfumes **6 Hours**

Jasmone, Civetone, Muscone.

List of Experiments for Practical: **15 Hours**

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CHY17RS11	**Pesticide Chemistry**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level **Course Category:** Program Core **Course Type:** Theory					

Objectives To make awareness among the students on pesticide chemicals and their applications.

Course Outcomes

CO1	Able to know the chemistry of pesticides.
CO2	Ability to structure-activity relationship of pesticides
CO3	Understand about organochlorines and organophosphates
CO4	Ability to analyze the reactivity of carbamates and quinines as pesticides
CO5	Evaluating and analyzing the role of anilides as pesticides

Mapping of Course Outcome(s):

CO/PO	**PO**				
	1	**2**	**3**	**4**	**5**
CO1	L		S		M
CO2		S	L		M
CO3	L		M		
CO4		L		M	S
CO5	M	S	L		S

Unit I – Introduction to Pesticides **6 Hours**

General introduction to pesticides (natural and synthetic), benefits and adverse effects

Unit II – Structure Activity Relationship **6 Hours**

Changing concepts of pesticides, structure activity relationship

Unit III – Organochlorines and Organophosphates **6 Hours**

Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexane,); Organophosphates (Malathion, Parathion).

Unit IV – Carbamates and Quinones **6 Hours**

Carbamates (Carbofuran and carbaryl); Quinones (Chloranil)

Unit V – Anilides **6 Hours**

Anilides (Alachlor and Butachlor)

List of Experiments for Practical: **15 Hours**

1. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

Reference Book:

Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.

CHY17RS12	Fuel Chemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives To familiarize the students on fuels and their uses.

Course Outcomes

CO1 Able to know the chemistry of fuels.
CO2 Understand the role of coal as a fuel
CO3 Ability to know the petroleum products and industry.
CO4 Understand and apply the petrochemical sources for suitable applications
CO5 Analyze the principles of lubrication process and lubricants

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		S		S
CO2		M	L		S
CO3	L		S		
CO4		M		M	M
CO5	M	S	L		

Unit I - Review of energy sources (renewable and non-renewable) **6 Hours**

Classification of fuels and their calorific value.

Unit II - Coal: **6 Hours**

Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit III - Petroleum and Petrochemical Industry: 6 Hours

Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking),Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Unit IV - Petrochemicals: **6 Hours**

Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Unit V- Lubricants: 6 Hours

Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants: (viscosity index, cloud point, pore point) and their determination.

Reference Books:

1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CHY17RS13	Food Chemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objective(s)

Course Outcome(s)

CO1	To familiarize the students on food chemistry
CO2	To understand about food poisoning
CO3	To acquire the knowledge on food additives and packaging of foods
CO4	To understand the food preservation methods.
CO5	To know chemistry of carbohydrates, proteins and amino acids.

Mapping of Course Outcome(s):

CO/PO	PO

	1	2	3	4	5
CO1	L		M		S
CO2		M	L		S
CO3	L		S	M	
CO4		M		L	M
CO5	M	S	L		

Unit-I: Food and its Adulteration **6 Hours**

Classification of food, functions of food, food metabolism, sources of food, processing of food, types. Food Adulteration – contamination of wheat, rice, milk, butter etc. with clay stones, water and toxic chemicals – Common adulterants – ghee adulterants and their detection.

Unit –II: Food Poison **6 Hours**

Diseases due to food stuffs-food poisoning and first aid to food poisoning-causes and remedies for acidity, gastritis, indigestion and constipation. Adulteration in some common food Items- milk, oils, ghee, coffee, powder, chilli powder and turmeric powder. Beverages: soft drinks – soda – fruit juices – alcoholic beverages examples. Carbonation – addiction of alcohol – cirrhosis of liver and social problems.

Unit- III: Food Additives and Packaging of Foods **6 Hours**

Food additives – artificial sweeteners – saccharin – cyclamate and aspartate. Food flavours –esters, aldehydes and heterocyclic compound. Food colours – natural and artificial –Emulsifying agents – preservative agents, Baking powder yeast – taste makers, Packaging of foods - classification-Materials used for packaging.

Unit-IV: Food Preservation **6 Hours**

Food Preservatives - definition - classification - Food Spoilage - definition - Prevention. Methods of preservation - classification - Low and high temperature - preservatives examples - Dehydration - osmotic pressure - food irradiation.

Unit- V: Carbohydrates, Proteins and Amino Acids **6 Hours**

Classification of carbohydrates, physical and chemical properties of polysaccharides. Manufacture of starch, functions of carbohydrates in human body, changes of carbohydrates on cooking - caramelisation. Classification of proteins, functions in human body, analysis of proteins. Composition of amino acids as building blocks, renaturation and denaturation of proteins**.**

Reference Books:

1. H.K. Chopra, P.S.Panesar, "Food Chemistry", Narosa Publishing House, 2010.
2. Thanlamma Jacob, "Textbook of applied chemistry" for home science and allied Science, MacMillan, 1976
3. Alex V.Ramani, "Food chemistry", MJP Publishers, Chennai, 2009.
4. Srilakshmi B, "Food Science", New age International publishers Pvt. Ltd, 2003.
5. Lilian Hoagland Meyer, Food Chemistry - CBS Publishers & Distributors, 2004.

CHY17RS14	Industrial Chemistry	L	T	P	C
		2	0	0	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Theory			

Objectives

To familiarize the students on fertilizers and pesticides.
To acquire the knowledge on petroleum and fuel gases.
To study the electrochemical devices.
To know chemistry of paints, varnishes and soaps.
To study the cement, glass and ceramics.

Course Outcomes

CO1 Know the chemistry of fertilizers and pesticides
CO2 Understand various petrochemical processes.
CO3 Understand batteries and fuel cells.
CO4 Familiarize the chemistry of paints, varnishes,.
CO5 Analyze the chemistry of cement, glass and ceramics

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S		M	S	
CO2		L			S
CO3	L		S	M	
CO4		M		L	M
CO5	M	S	L		

Unit –I: Fertilizers and Pesticides **6 Hours**

Fertilizers: natural fertilizers, nitrogenous fertilizer (NH_4NO_3 ,urea), phosphatic fertilizer (superphosphate, TSP), potash fertilizer (KCl, KNO_3), biofertilizers. Pesticides: classification, structure of some important pesticides (DDT, BHC, allethrin and pyrethrin).

Unit- II: Petroleum and Fuel Gases **6 Hours**

Petroleum: Origin, refining, Cracking, reforming ,knocking and octane number, LPG, synthetic gas, synthetic petrol.

Fuel Gases: Large scale production, storage, hazards and uses of coal gas, water gas, producer gas, and oil gas.

Unit- III: Electrochemical Industries **6 Hours**

Production of materials like chlorine, caustic soda ,sodium chlorate, Batteries –

primary and secondary cells, solar cells, fuel cells.

Unit- IV: Paints, Varnishes and Soaps **6 Hours**

Paints & Varnishes: Primary constituents of paints, Dispersion medium (solvent), binder Pigments, formulation of paints and varnishes. Requirements of a good paint.

Soaps: manufacture of soaps by hot and cold process, classification of soap, cleansing of soap and classification of detergents (anionic and cationic).

Unit V: Cement, Glass and Ceramics **6 Hours**

Cement: Manufacturing – Wet Process and Dry process, types, analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India.

Glass: Composition and manufacture of glass .Types of glasses- optical glass, coloured glasses and lead glass.

Ceramics: Types- raw materials – white wares, manufacture and uses.

Reference Books:

1. B.N.Chakrabarty, Industrial Chemistry, Oxford & IBH Publishing Co, New Delhi, 1981.
2. B.K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut
3. P.P.Singh, T.M.Joseph, R.G.Dhavale, College Industrial Chemistry, Himalaya Publishing House, Bombay, 4th Ed., 1983.

CHY17RS15	Agricultural And Leather Chemistry	L	T	P	C
		2	0	0	2

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level

Course Category: Program Core **Course Type:** Theory

Objectives

This course will introduce agricultural chemical concepts.
To learn and acquire knowledge on pesticides and insecticides
Help in the students to understand about leather industrial chemistry and acquire knowledge on the problems of pollution due to these industries.

Course Outcomes

CO1	To analyze and study the properties of soil.
CO2	Understand about fertility management.
CO3	Know about chemistry pesticides and insecticides.
CO4	Acquire knowledge about skin processing and polluting effects of tannery effluents.
CO5	To study about the effluents in leather industries and their treatment processes

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		S	L	
CO2		L			S
CO3	L		S	S	
CO4		M		L	M

CO5	M	S	L		

Unit- I: Soil Chemistry **6 Hours**

Soil Chemistry**:** Formation of Soil. Classification of soil and properties of soil - soil Acidity - Causes of acidity - soil alkalinity - determination of soil pH - Buffering of soils - Amending the soil - Reclamation of acid soil - Liming agents.

Unit- II: Soil Fertility and Productivity **6 Hours**

Soil Fertility and Productivity: Fertilizers - Effect of Nitrogen, potassium and phosphorous on plant growth – commercial method of preparation of urea, triple superphosphate. Complex fertilizers and mixed fertilizers – their manufacture and composition. Secondary nutrients – micronutrients – their function in plants. Manures : Bulky organic manures – Farm yard manure – handling and storage-oil cakes- blood meal – fish manures.

Unit - III: Pesticides and Insecticides **6 Hours**

Pesticides and Insecticides**:** Pesticides – classification of Insecticides, fungicides, herbicides as organic and inorganic – general methods of application and toxicity. Safety measures when using pesticides. Insecticides: Plant products – Nicotine, pyrethrin – Inorganic pesticides – borates. Organic pesticides – DDT and BHC.

Unit -IV: Leather Chemistry **6 Hours**

Leather Chemistry**:** Constituents of Animal Skin - Preparing skins and hides - Cleaning and soaking - Liming and degreasing - Manufacture of Leather - Leather Tanning - Vegetable Tanning - Chrome Tanning and Mineral Tanning - Dyeing and Fat liquoring - Leather finishing - oil tanning - by products.

Unit V Tannery Effluents **6 Hours**

Tannery Effluents - Pollution and Its Control - Water Pollution and Air Pollution - Waste Management - Primary, Secondary - Tertiary Treatment - Pollution Prevention.

Reference Books:

1. B.K. Sharma , Industrial Chemistry, Goel Publishing House, Meerut.
2. K.Bhagavathi - Sundari,, Applied Chemistry , MJP Publishers.
3. Jayashree Ghosh,, Fundamental concept of Applied Chemistry, S. Chand & Company Ltd.,
4. J. Partridge Noyes, Park Ridge,N.J , Chemical Treatment of Hides and Leather.
5. B.A. Yagodin , Agricultural Chemistry,Vol I & Vol II , New Century books (P) Ltd.,
6. Louis M.Thompson - and Frederick. R.Troch, Soils and Soil Fertility, Tata Mc. Graw Hill.
7. T.D. Biswas and S.K. Mukerjee, Textbook of Soil Science, II Edition.
8. Fundamental of Leather Science - Woodroffe Publications of CLRI - Chennai.

DISCIPLINE SPECIFIC ELECTIVES

CHY17R321	Applications of Computers in Chemistry	L	T	P	C
		4	0	4	6
Pre-requisite: An exposure to computer applications at the elementary school level **Course Category:** Program Core **Course Type:** Integrated Course					

Objective(s) To know the applications of computers in chemistry.

Course Outcome(s)

CO1 Basic knowledge of BASIC programming language
CO2 Constructing simple programs using matrix
CO3 Employing numerical methods in programming language
CO4 Understanding of the simultaneous equations
CO5 Elementary principles of molecular modeling and its applications

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		M	M	
CO2		S	L		M
CO3	S		L	M	
CO4		L		S	M
CO5	M		L		M

Unit-I Computer Basics: 12 Hours

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions.

Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics.

Unit-II Computer Softwares 12 Hours

Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Unit-III Numerical methods: 12 Hours

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

Unit-IV Mathematical Methods for Data Processing 12 Hours

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss - Seidel method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

Unit-V Basics of Molecular Modeling 12 Hours

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Reference Books:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levier. de, *How to use Excel in Analytical Chemistry and in General Scientific Data Analysis*, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. *Physical Chemistry on a Microcomputer,* Little Brown & Co. (1985).
4. Venit, S.M., Programming in BASIC: Problem Solving with Structure and Style, Jaico Publishing House: Delhi (1996).

***List of Experiments for Practical*:** **30 Hours**

Computer programs based on numerical methods for

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, *p*H of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Seidel method in colorimetry.
5. Simple exercises using molecular visualization software.

Reference Books:

1. McQuarrie, D. A. *Mathematics for Physical Chemistry,* University Science Books (2008).
2. Mortimer, R. *Mathematics for Physical Chemistry*, 3rd Ed. Elsevier (2005).
3. Steiner, E. *The Chemical Maths Book,* Oxford University Press (1996).
4. Yates, P. *Chemical Calculations.* 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*, 6th Ed., Freeman (2007) Chapters 3-5.
6. Levier. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H., *Physical Chemistry on a Microcomputer.* Little Brown & Co. (1985).
8. Venit, S.M., Programming in BASIC: Problem Solving with Structure and Style, Jaico Publishing House: Delhi (1996).

CHY17R322	Analytical Methods in Chemistry	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) To apply the various analytical and spectroscopic methods in estimating and separating metal ions and compounds, respectively.

Course Outcome(s)

CO1 Understanding qualitative and quantitative aspects of analysis

CO2 Knowledge of spectrophotometric analysis and its applications

CO3 Estimation of metal ions in trace levels using flame spectrometric techniques

CO4 Importance of thermal and electroanalytical methods of analysis in qualitative and quantitative measurements

CO5 Obtaining knowledge about qualitative and quantitative aspects of separation techniques

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S		M	M	
CO2		S	S		M
CO3	S		L	L	
CO4		L		S	M
CO5	M		L		M

Unit I Qualitative and quantitative aspects of analysis: 12 Hours

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit II Optical methods of analysis: 12 Hours

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data.

Unit III Flame Atomic Absorption and Emission Spectrometry 12 Hours

Flame Atomic Absorption and Emission Spectrometry: Basic principles of

instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit IV Thermal and Electroanalytical Methods of Analysis 12 Hours

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit V Separation techniques 12 Hours

Solvent extraction: Classification, principle and efficiency of the technique. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Reference Books:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988.
3. Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Horwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

List of Experiments for Practical: **30 Hours**

I. Separation Techniques

Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify

them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

1. Separation of a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} DMG complex in chloroform, and determine its concentration by spectrophotometry.
2. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of iron and gallium.
3. Determine the *p*H of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:
    a. Determination of *p*H of soil.
    b. Total soluble salt
    c. Estimation of calcium, magnesium, phosphate, nitrate
6. Ion exchange:
    a. Determination of exchange capacity of cation exchange resins and anion exchange resins.
    b. Separation of metal ions from their binary mixture.
    c. Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of *p*Ka values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York,2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*,

Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

CHY17R323	Molecular Modeling and Drug Design	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To understand the basic knowledge of molecular modeling and drug design.

Course Outcome(s)

CO1	Understanding basic principles of molecular modeling
CO2	Employing force field models for simulation studies
CO3	Gathering of knowledge on molecular Dynamics & Monte Carlo Simulation
CO4	Importance of thermal and electroanalytical methods of analysis in qualitative and quantitative measurements
CO5	Applying molecular modeling techniques for drug design and discovery

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S		M	M	
CO2		S	S		M
CO3	L			L	
CO4		L		S	S
CO5	M		L		L

Unit I Introduction to Molecular Modeling **12 Hours**

Introduction: Useful Concepts in Molecular Modeling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

Unit II Force Fields **12 Hours**

Fields. Bond Stretching. Angle Bending. Introduction to non-bonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Unit III Energy Minimization and Computer Simulation **12 Hours**

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

Unit IV Molecular Dynamics & Monte Carlo Simulation **12 Hours**

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

Unit V Structure Prediction and Drug Design **12 Hours**

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR.

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S.P. QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

***List of Experiments for Practical*:** **30 Hours**

1. Comparison of the optimized C-C bond lengths in ethane, ethene, ethyne and benzene.
   Visualization of the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.
   (a) Performing a conformational analysis of butane.
   (b) Determination of the enthalpy of isomerization of *cis* and *trans* 2-butene.
2. Visualization of the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comments related to the dipole moments. Animation of the vibrations of these molecules.
3. (a) Relationship between the charge on the hydrogen atom in hydrogen halides with their acid character.
   (b) Comparison of the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
4. (a) Comparison of the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Noting the dipole moment of each molecule.
   (b) Interpreting the relationship between shapes and their effects in the trend observed in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
5. Building and minimizing organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound:
   (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
6. (a) Determination of the heat of hydration of ethylene.
   (b) Computing the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
7. Arranging 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
8. (a) Comparing the optimized bond angles of H_2O, H_2S and H_2Se.
   (b) Comparing the HAH bond angles for the second row dihydrides and comparing with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Reference Books:

1. Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
2. Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
3. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

CHY17R324	Novel Inorganic Solids	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level

Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To assimilate the importance and applications of functional and composite materials and to know the application of polymers in industries.

Course Outcome(s)

CO1	Acquiring knowledge of various inorganic material synthesis techniques
CO2	Knowing the classification and importance of functional inorganic nanomaterials
CO3	Application of engineering materials for construction purpose
CO4	Knowing the importance of composite materials and its applications
CO5	Understanding the applications of industrially important polymers

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		M	S	
CO2		S	L		M
CO3	S			L	
CO4		M		M	S
CO5	M		S		L

Unit I Synthesis and Modification of Technologically Important Inorganic Solids **12 Hours**

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

Inorganic solids of technological importance:

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.

Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.

Unit II Nanomaterials **12 Hours**

Overview of nanostructures and nanomaterials: classification.

Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control.

Carbon nanotubes and inorganic nanowires.

Bio-inorganic nanomaterials, DNA and nanomaterials, natural and artificial

nanomaterials, bionanocomposites.

Unit III Introduction to engineering materials for mechanical construction 12 Hours

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminium and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

Unit IV Composite materials 12 Hours

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Unit V Speciality Polymers 12 Hours

Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Reference Books:

1. Shriver & Atkins. *Inorganic Chemistry*, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley & Sons, 1974.
3. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley & Sons, 2003.
4. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

List of Experiments for Practical: **30 Hours**

1. Determination of cation exchange method
2. Determination of total difference of solids.
2. Synthesis of hydrogel by co-precipitation method.
3. Synthesis of silver and gold metal nanoparticles.

Reference Book:

Fahlman, B.D. *Materials Chemistry*, Springer, 2004.

CHY17R325	Polymer Chemistry	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Integrated Course			

Objective(s) To learn the structures, functions, properties and polymerization mechanisms of polymers.

Course Outcome(s)

CO1 Understanding the classification, structure, function and importance of

	polymers
CO2	Examining the kinetics and mechanism of polymerization
CO3	Acquiring the knowledge on nature and physical properties of polymers
CO4	Knowing the solubility parameters, thermodynamic properties and methods to determine molecular weight of polymers
CO5	Analyzing the synthesis of different polymers and examining their properties

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	L		M	S	
CO2		S	L		M
CO3	S			L	
CO4		M		M	S
CO5	M		S		L

Unit I Introduction and Importance of Polymeric Materials **12 Hours**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers.

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

Unit II Kinetics of Polymerization **12 Hours**

Mechanism and kinetics of step growth, radical chain growth and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Unit III Structure and Morphology of Polymers **12 Hours**

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Glass transition temperature (Tg): Determination of Tg Factors affecting glass transition temperature (Tg).

Unit IV Nature and structure of polymers **12 Hours**

Structure Property relationships.

Polymer Solutions – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Lower and Upper critical solution temperatures.

Determination of molecular weight of polymers (*Mn*, *Mw*, etc) light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Unit V Preparation and Properties of Polymers **12 Hours**

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl

acetate), acrylic polymers, fluoropolymers, polyamides.

Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Reference Books:

1. Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
2. Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
5. Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.

List of Experiments for Practical: **30 Hours**

Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) /Methyl Acrylate (MA) / Acrylic acid (AA).
    a. Purification of monomer
    b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutyronitrile (AIBN)
2. Preparation of nylon 6,6/6
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
    a. Preparation of IPC
    b. Purification of IPC
    c. Interfacial polymerization
4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparations of novolac resin / resole resin.
8. Microscale Emulsion Polymerization of Poly(methyl acrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
    (i) Polyacrylamide-aq.$NaNO_2$ solution
    (ii) (Poly vinyl pyrrolidone (PVP) in water
2. Determination of the viscosity-average molecular weight of polyvinyl alcohol (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

**at least 7 experiments to be carried out.*

Reference Books:

1. M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
3. F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
4. J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
5. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
7. M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CHY17R326	Research Methodology for Chemistry	L	T	P	C
		5	1	0	6

Pre-requisite: Basic knowledge of statistical and numerical methods at the secondary school level

Course Category: Program Core **Course Type:** Theory

Objective(s) To introduce the concept of scientific research and the methods of conducting scientific enquiry

Course Outcome(s)

CO1	Basic knowledge and understanding different tools of literature survey
CO2	Understanding the methods of writing a manuscript and practicing scientific research
CO3	Knowing the importance of safe laboratory practice
CO4	Acquiring the knowledge of data analysis
CO5	Understanding the simple electronic circuits and their implementation in analytical instruments

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	S		M	S	
CO2		M	L		M
CO3	L			M	

CO4		S		L	S
CO5	M		S		L

Unit I Literature Survey **15 Hours**

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Sciencedirect, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web.Internet resources for chemistry. Finding and citing published information.

Unit II Methods of Scientific Research and Writing Scientific Papers: **15 Hours**

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work.

Writing thesis. Avoiding plagiarism.

Unit III Chemical Safety and Ethical Handling of Chemicals: **15 Hours**

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit IV Data Analysis **15 Hours**

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.

Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

Unit V Electronics **15 Hours**

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
3. Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall,

London.
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

CHY17R327	Green Chemistry	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level

Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To impart the knowledge of green chemistry and ensure the establishment of the principles of green chemistry

Course Outcome(s)

CO1	Understanding and utilizing the basic principles of green chemistry
CO2	Knowing the importance of employing green chemistry principles
CO3	Importance of catalyst to achieve the principles of green chemistry
CO4	Acquiring knowledge of greener synthetic methods in real world cases
CO5	Ensuring the future trends and importance of greener synthetic methods

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		M		S
CO2		M	S		
CO3	S			S	M
CO4		S	M	L	
CO5	M		L		L

Unit I Introduction and Principles **12 Hours**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis:

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

Unit II Applications of Green Chemistry Principles **12 Hours**

Prevention/ minimization of hazardous/ toxic products reducing toxicity.

risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic

liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.

Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.

Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.

Unit III Green Chemistry Methods and Processes 12 Hours

Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carbaryl) and Flixborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit IV Green Syntheses and Reactions 12 Hours

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents
3. Diels-Alder reaction and Decarboxylation reaction
4. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
5. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
6. Designing of Environmentally safe marine antifoulant.
7. Rightfit pigment: synthetic azo pigments to replace toxic organic and inorganic pigments.
8. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
9. Healthier fats and oil by Green Chemistry: Enzymatic inter esterification for production of no Trans-Fats and Oils
10. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Unit – V Future Trends in Green Chemistry 12 Hours

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co-crystal controlled solid state synthesis (C_2S_3); Green chemistry in sustainable development.

Reference Books:

1. Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
4. Cann, M.C. & Connelly, M.E. *Real-World cases in Green Chemistry*, American

Chemical Society, Washington (2000).

5. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
6. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

***List of Experiments for Practical*:** **30 Hours**

1. **Safer starting materials**
   Preparation and characterization of nanoparticles of gold using tea leaves.
2. **Using renewable resources**
   Preparation of biodiesel from vegetable/ waste cooking oil.
3. **Avoiding waste**
   Principle of atom economy.
   Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
   Preparation of propene by two methods can be studied
   (I) Triethylamine ion + OH^- → propene + trimethylpropane + water
   (II) 1-propanol + H_2SO_4/Δ → propene + water
   Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.
4. **Use of enzymes as catalysts**
   Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
5. **Alternative Green solvents**
   Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice. Mechanochemical solvent free synthesis of azomethines.
6. **Alternative sources of energy**
   Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
   Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchhoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhuri, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore ISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text,* RSC Publishing, 2nd Edition,

2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G., Introduction to Organic Laboratory Techniques: A Microscale and Macroscale Approach, W.B.Saunders, 1995.

CHY17R328	Industrial Chemicals and Environment	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To inculcate the environmental awareness of handling hazardous chemicals and ensure the environmental safety

Course Outcome(s)

CO1	Bulk synthesis and handling the industrially important hazardous chemicals and gases
CO2	Understanding the industrial preparation and purification of metals
CO3	Able to explain the environmental impacts of toxic chemicals in atmosphere
CO4	Able to explain the environmental impacts of toxic chemicals in hydrosphere
CO5	Correlate the importance of energy sources and their environmental impacts

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L		M	M	L
CO2		L			
CO3	S			S	M
CO4		S	S	L	
CO5	M	M	L		L

Unit I Industrial Gases and Inorganic Chemicals **12 Hours**

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Unit II Industrial Metallurgy **12 Hours**

Chief modes of occurrence of metals based on standard electrode potentials.

Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Unit III Environment and its Segments Part A **12 Hours**

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Unit IV Environment and its Segments **12 Hours**

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

Unit V Energy & Environment **12 Hours**

Sources of energy: Coal, petroleum and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydro, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.*
4. *S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.

5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

***List of Experiments for Practical*:** **30 Hours**

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO^{3-}) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bioindicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

CHY17R329	Inorganic Materials of Industrial Importance	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level
Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To gain knowledge on industrially important inorganic materials for various applications

Course Outcome(s)

CO1 Understanding the periodicity of *s* and *p* block elements
CO2 Acquiring knowledge on industrial application of silicate materials
CO3 Obtaining knowledge on important inorganic materials used as fertilizers and

surface coatings

CO4 Gathering the knowledge of inorganic materials used as batteries and alloys

CO5 Understanding the principles of catalyst chemistry and explosives materials

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	M		S		L
CO2		L	L	M	S
CO3	S			S	M
CO4		S	M	L	
CO5	L	M			L

Unit I Recapitulation of *s*- and *p*-Block Elements 12 Hours

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Allred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Unit II Silicate Industries 12 Hours

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit III Fertilizers and Surface Coatings Fertilizers: 12 Hours

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit IV Batteries and Alloys Batteries: 12 Hours

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

*Alloys:*Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorization) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Unit V Catalysis and Chemical Explosives: 12 Hours

Catalysis: General principles and properties of catalysts, homogeneous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.
Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain & M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkatappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
7. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

***List of Experiments for Practical*: 30 Hours**

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of calcium in calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.

6. R. Gopalan, D. Venkatappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

CHY17R330	Instrumental Methods of Chemical Analysis	L	T	P	C
		4	0	4	6
Pre-requisite: An exposure to scientific principles at the higher secondary course level **Course Category:** Program Core **Course Type:** Integrated Course					

Objective(s) To apply instrumentation techniques for chemical analysis

Course Outcome(s)

CO1	Delineate the important spectroscopic methods of analysis and interpretation of spectral data
CO2	Applying and understanding the chromatographic techniques
CO3	Understanding the principles, instrumentation and application of mass spectrometry
CO4	Utilizing atomic absorption and emission spectroscopic techniques for elemental analysis
CO5	Illustrating the principles, instrumentation and application of NMR and electroanalytical methods

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L	M	S		
CO2		L		M	S
CO3	S		L	S	M
CO4		S	M	L	
CO5	M	M			L

Unit I: Introduction to Spectroscopic Methods of Analysis, Molecular Spectroscopy: 12 Hours

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Molecular Spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat,differential detection), interpretation of spectrum (qualitative, mixtures,

resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

Unit II: Separation Techniques (*Chromatography*) 12 Hours

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Unit III: Mass Spectroscopy*:* **12 Hours**

Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

Unit IV: Elemental Analysis: 12 Hours

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

Unit V: NMR spectroscopy: **12 Hours**

Principle, Instrumentation, Factors affecting chemical shift, Spincoupling, Applications.

Electroanalytical Methods: Potentiometry & Voltammetry

Radiochemical Methods

X-ray analysis and electron spectroscopy (surface analysis)

Reference books:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.

6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.

***List of Experiments for Practical*:** **30 Hours**

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do "presumptive tests" to identify blood or other body fluids.
16. Use of "presumptive tests" for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

At least 10 experiments to be performed.

Reference Books:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

CHY17R331	Quantum Chemistry, Spectroscopy and Photochemistry	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) To study the basic principles, and applications of quantum chemistry,

spectroscopy and photochemistry.

Course Outcome(s)

CO1	Understand the basic concept of quantum chemistry and its applications.
CO2	Applying the Schrodinger equation in simple systems and understanding the quantum mechanical concept of bonding theory.
CO3	Gathering the basic knowledge of spectroscopy and its application.
CO4	Understanding the principle, application of Electronic, NMR, ESR spectroscopy.
CO5	Acquiring knowledge about photochemistry and its applications.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	L	M	S		
CO2		L		M	S
CO3	S		L		M
CO4		S	M	L	
CO5	M	S			L

Unit I: Quantum Chemistry **12 Hours**

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Unit II: Atomic Structure and Bonding **12 Hours**

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2.

Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO

treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Unit III: Molecular Spectroscopy: 12 Hours

Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Unit IV: Absorption Spectroscopy 12 Hours

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Unit V: Photochemistry 12 Hours

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference Books:

1. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy,* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. *Introductory Quantum Chemistry,* Tata McGraw-Hill (2001).
3. House, J. E. *Fundamentals of Quantum Chemistry*, 2nd Ed, Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

***List of Experiments for Practical*: 30 Hours**

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two

transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colorimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration

II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein).

VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.

VII. Analyse the given vibration-rotation spectrum of HCl (g)

Reference Books

1. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
2. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CHY17R332	Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level **Course Category:** Program Core **Course Type:** Integrated Course					

Objective(s) To know the concepts of organometallics, bioinorganic chemistry, polynuclear hydrocarbons and UV, IR spectroscopy.

Course Outcome(s)

CO1	Study the oxidation states of different metals and the properties of metallic compounds.
CO2	Gain the knowledge about the bonding and structure of organometallic compounds.
CO3	Introduce bio-inorganic chemistry and analyze the role of metal ions in biological processes.
CO4	Illustrate the properties of polynuclear, heteronuclear aromatic compounds and active methylene compounds.
CO5	Apply spectroscopic techniques in analyzing the structure of simple organic molecules.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	L	S		
CO2		M		L	S
CO3	S		L		M
CO4		M	S	L	
CO5	L	S			M

Unit I: Chemistry of 3d metals **12 Hours**

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit II: Organometallic Compounds **12 Hours**

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach) - (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Unit III: Bio-Inorganic Chemistry **12 Hours**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to $Na^{+,}$ K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Unit IV: Polynuclear and heteronuclear aromatic compounds and Active methylene compounds: **12 Hours**

Polynuclear and heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine.

Active methylene compounds:

Preparation: Claisen ester condensation. Keto-enol tautomerism.

Reactions: Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).

Unit V: Application of Spectroscopy to Simple Organic Molecules **12 Hours**

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules.

Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α,β – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen

bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Reference Books:

1. James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
2. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley & Sons.
5. I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds,* Prentice Hall.
7. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds,* John Wiley & Sons.
8. R.T. Morrison & R.N. Boyd: *Organic Chemistry,* Prentice Hall.
9. Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
10. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

***List of Experiments for Practical*:** **30 Hours**

Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case.
   (Combination of two ions to be given)
   Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or
   Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}
2. Preparation of any two of the following complexes and measurement of their conductivity:
   (i) tetraamminecarbonatocobalt (III) nitrate
   (ii) tetraamminecopper (II) sulphate
   (iii) potassium trioxalatoferrate (III) trihydrate
   Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.

Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing mono functional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Reference Books:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry,* Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

CHY17R333	Molecules of Life	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry and Biology at the secondary school level					
Course Category: Program Core	**Course Type:** Integrated Course				

Objective(s) To assimilate the importance of biomolecules and energy conversion

reactions.

Course Outcome(s)

CO1	Study the classification, structures and properties of carbohydrates.
CO2	Know the classification and synthetic methods of amino acids, peptides and proteins.
CO3	Analyze the mechanisms of enzyme and drug actions and study the structure –activity relationships of some drug molecules.
CO4	Classify the components of nucleic acids and lipids and understand the roles of DNA, RNA, triglycerides, phospholipids, glycolipids, and steroids in biological systems.
CO5	Understand the concept of energy conversion in biological systems.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	L	L	S		
CO2		L		L	S
CO3	S		L		L
CO4		L	S	L	
CO5	L	S			M

Unit I: Carbohydrates **12 Hours**

Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers.

Determination of configuration of Glucose (Fischer proof).

Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Unit II: Amino Acids, Peptides and Proteins **12 Hours**

Classification *of Amino Acids,* Zwitterion structure and Isoelectric point.

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

Unit III: Enzymes and correlation with drug action **12 Hours**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action(Including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Noncompetitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring.

Unit IV: Nucleic Acids **12 Hours**

Components of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(**nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Unit V: Lipids **12 Hours**

Introduction to lipids, classification.

Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit VI: Concept of Energy in Biosystems **12 Hours**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.

Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins.

Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Recommended Texts:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed.*, W. H. Freeman.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.

***List of Experiments for Practical*:** **30 Hours**

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
2. Effect of temperature on the action of salivary amylase on starch.
3. To determine the saponification value of an oil/fat.
4. To determine the iodine value of an oil/fat
5. Differentiate between a reducing/ nonreducing sugar.
6. Extraction of DNA from onion/cauliflower
7. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

Recommended Texts:

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry,* ELBS.

2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

CHY17R334	Nanochemistry	L	T	P	C
		4	0	4	6

Pre-requisite: Basic knowledge of Chemistry and Physics at the higher secondary course level

Course Category: Program Core **Course Type:** Integrated Course

Objective(s) To stimulate the learner in understanding the basic concepts and applications of nanochemistry.

Course Outcome(s)

CO1	Understand the basic concepts and classification of nanomaterials.
CO2	Study the common properties and size dependent absorption behavior of nanomaterials.
CO3	Demonstrate the physical and chemical synthetic routes of nanomaterilals.
CO4	Analyze the application of nanomaterials in various fields including catalysis, photonics, and medicine.
CO5	Characterize the nanomaterials using various microscopic techniques.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	L	M	S		
CO2		L		M	S
CO3	S		L		M
CO4		M	S	L	
CO5	M	S			L

Unit-I: Basics of Nanochemistry **12 Hours**

Basics of nanomaterials: Properties of nanomaterials, quantum confinement effect, surface to volume ratio, surface properties of nanoparticles. Classification of the nano materials – zero dimensional, one dimensional, two dimensional and three dimensional nanostructures.

Unit-II: Properties of Nanomaterials **12 Hours**

Mechanical, optical, electronic, magnetic, thermal and chemical properties of

nanomaterials. Size dependent properties-size dependent absorption spectra

Unit-III: Synthetic Techniques **12 Hours**

Chemical methods: sol-gel synthesis, solvothermal synthesis, thermolysis route. Physical methods: Pulsed laser deposition- Magnetron sputtering

Unit-IV: Applications of Nanomaterials **12 Hours**

Catalysis on nanoparticles, semiconductors, sensors, and electronic devices, photochemistry and nanophotonics, applications of CNTs, nanomaterials in biology and medicine.

Unit-V: Characterization Techniques **12 Hours**

X-ray diffraction- Electron microscopes – scanning electron microscopes (SEM) – transmission electron microscopes (TEM) – scanning probe microscopy – atomic force microscopy (AFM) – scanning tunneling electron microscope (STEM) – basic principles only.

Reference Books:

1. S.Shanmugam, Nanotechnology, MJP Publishers, Chennai (2010).
2. Patrick Salomon, A Handbook on Nanochemistry, Dominant Publishers and Distributers, New Delhi.
3. S. Balaji , Nanobiotechnology, MJP Publishers, Chennai (2010).
4. CNR Rao The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, Springer (2006).
5. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005).
6. G. B. Segreev, Nanochemistry, , Elsevier, Science, New York, (2006).
7. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, "The Chemistry of Nanomaterials: Synthesis, Properties and Applications" WILEY-VCH Verlag GmbH & Co. KGaA, weinheim, 2004
8. C.N.R. Rao, G.U. Kulkarni, P.J. Thomas, Nanocrystals: Synthesis, Properties and Applications" Springer Series in materials science-95, Springer-Verlag Berlin Heidelberg 2007
9. Znong Lin Wang, "Characterization of nanophase materials" WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2000.

List of Experiments for Practical **30 Hours**

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol; Mie formalism; Estimation of size by curve fitting
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge
3. Synthesis of ZnS nanoparticles by chemical route and determination of band structure through UV-Vis spectroscopy.
4. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by

UV- Visible absorption.

5. Sol gel synthesis of ZnO nanoparticles
6. Room temperature B-H loops for γ-Fe_2O_3 nanoparticles of different sizes (5-50 nm).
7. Synthesis and characterization of SiO_2 Spheres.
8. Determination of size and lateral dimensions of various samples (pollen grains, strands of hair) using a high magnification optical microscope.

CHY17R335	Materials Science	L	T	P	C
		5	1	0	6

Pre-requisite: Basic knowledge of Physics and Chemistry at the higher secondary course level

Course Category: Program Core **Course Type:** Theory

Objective(s) To acquire a widespread knowledge about conducting, semiconducting and superconducting materials and their applications.

Course Outcome(s)

CO1	Understand the basic concept of crystallography and analyze the geometry and crystal imperfections.
CO2	Study the theory and characteristics of conducting and semiconducting materials.
CO3	Understand the theory and properties of magnetic and dielectric materials.
CO4	Introduce superconducting materials and understand electron-phonon interaction.
CO5	Employ the optical and luminescence properties of materials in various applications.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1	M	M	L		
CO2		L		M	S
CO3	S		M		L
CO4			S	L	
CO5	L	S		S	M

Unit-I: Crystal geometry and Crystal imperfections **15 Hours**

Introduction–Fundamental terms of crystallography–Types of crystals– Crystal structures of materials – Simple cubic crystal structure – Body centered cubic structure–Face centered cubic structure – Hexagonal closed packed structure-Crystal imperfections – point defects – line defects – planar defects – bulk defects – Dislocations – Burger Vector.

Unit-II: Conducting and Semiconducting Materials **15 Hours**

Draw backs of classical theory – Fermi distribution function – Density of energy states (derivation) – effect of temperature on Fermi energy (Qualitative), Origin of band gap in solids (qualitative treatment only) – Concept of effective mass of electron and hole – Law of mass action – Carrier concentration in an intrinsic semiconductor (derivation) – electrical conductivity – band gap determination – Carrier concentration in n-type and p-type semiconductors (Qualitative) – Variation of Fermi level with temperature and impurity concentration (Qualitative) – Hall effect – Determination of Hall coefficient.

Unit-III: Magnetic and Dielectric Materials **15 Hours**

Origin of magnetic moment – Bohr magneton – Weiss theory of paramagnetism, Ferromagnetism – Domain theory of ferromagnetism, Hysteresis – Ferites – magnetic recording and readout – Storage of data – Tapes and floppy - magnetic disk drives. Dielectric materials: Electronic, Ionic, Orientational, Spontaneous and space charge polarization – Complex dielectric constant RC equivalent network – dielectric loss – different types of dielectric breakdown—Classification of insulating materials (qualitative).

Unit-IV: Superconducting Materials **15 Hours**

Introduction–General properties of superconducting materials–Types of superconductors–Bardeen, Cooper and Schrieffer (BCS) theory– Electron-Phonon interaction – High temperature superconductors – Applications.

Unit-V: Optical and Luminescence Properties of Materials **15 Hours**

Introduction – Classification of optical materials – Absorption in metals, insulators and semiconductors – Traps – Excitons – Colour centres – Principle and classification of luminescence materials – Photoluminescence – Phosphors – Cathodoluminescence – Electroluminescence – Applications.

Reference Books:

1. C.M. Srivatsava and C.Srinivasan, Science of Engineering Materials, 2nd Edition, New Age International (P) Ltd., Publications, New Delhi, 1997.
2. G.Kenneth, Budinski, Michel K., Budinski, Engineering materials Properties and Selection, 7th Edition, Pearson, Singapore (Printice Hall), 2002.
3. A.S.Vasudeva, Modern Engineering Physics, 2nd Edition, S.Chand and Co., Ltd., New Delhi 2003.
4. William F.Smith, Foundations of Materials Science and Engineering, 3rd Edition, McGraw Hill, New York, 2003.
5. V.Rajendran and A.Marikani, Materials Science, Tata McGraw Hill Publishers, New Delhi, 2004.

CHY17R336	Applied Chemistry	L	T	P	C
		4	0	4	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core		**Course Type:** Integrated Course			

Objective(s) To create the innovative knowledge of applied chemistry in the fields of water analysis, electrochemistry, corrosion, fuels and polymers.

Course Outcome(s)

CO1	Analyze the sources, impurities, and hardness of water and various methods of softening the water.
CO2	Understand the basic concepts of electrochemistry.
CO3	Study the concept of corrosion and develop corrosion prevention methods.
CO4	Illustrate the classification and properties different fuels.
CO5	Study the types and synthetic methods of polymers and employ the polymers in various applications.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	S	M	L		
CO2		S		M	L
CO3	M		S		L
CO4		S		L	M
CO5	L			S	M

Unit-I: Water Treatment **12 Hours**

Brief introduction regarding sources, impurities in water. Hardness of water, types, determination of hardness using EDTA method. Brief discussion and chemistry involved in the process of sedimentation, coagulation, filtration and sterilization, UV, Ozone, chlorination including break point chlorination. Softening of Water: (i) Lime-soda, process: Principles in hot, cold, lime-soda process. (ii) Zeolite softener, demineralization by synthetic ion exchange resins, Comparison between lime-soda, Zeolite and ion exchange process.

Unit-II: Electrochemistry **12 Hours**

Introduction, Arrhenius ionic theory, Debye-Huckel theory of strong electrolytes, Activity and Activity coefficient, Conductivity of electrolytes, Kohlrausch's law of independent migration of ions, Oswald's dilution law, Acids and Bases, Concept of pH and pOH , Buffer solutions, Solubility product, common ion effect, Hydrolysis of salts, Conductometric titrations, transport number. Potentiometric titrations.

Unit-III: Corrosion of Metals and Alloys **12 Hours**

Definition and classification of corrosion. Electrochemical corrosion- General revision of concept of electrode potential, galvanic cells, electrochemical and galvanic series, causes of corrosion, mechanism of direct chemical attack, pilling- Bed worth rule, concentration cells. Differential aeration theory of corrosion, types of corrosion, pitting corrosion, intergranular stress, waterline and microbial corrosion. Corrosion prevention : (a) Design and material selection, (b) Anodic and Cathodic inhibitors, (c) Cathodic and Anodic protection, (d) Protective coatings- types of surface, coatings and its application.

Unit-IV: Fuels **12 Hours**

Introduction, Classification of fuels, Calorific value, Characteristics of a good fuel, comparison between solid, liquid and gaseous fuels. Bomb calorimeter. Calorific value of a gaseous fuel, Theoretical calculation of calorific value of a fuel, Wood, Coal, Classification of coal, selection of coal , analysis of coal, Types of carbonization of coal. Diesel engine fuel, Petroleum, synthetic petrol. LPG as a fuel. Non petroleum fuels, Natural gas, Coal gas, water gas. Non conventional sources of energy-bio mass, biogas, wind energy, solar.

Unit-V: Polymers **12 Hours**

Introduction, Nomenclature and functionality of polymers, Classification of polymers, Types of polymersation. Methods of polymerization, Characteristics of polymers, structure and properties of polymers. Plastics, Inorganic polymers, Silicones, Rubbers, vulcanization of rubbers, synthetic rubber or elastomers, Application of rubber, Conducting polymers and bio polymers.

Reference Books:

1. S.S. Dara, A Text Book of Engineering Chemistry, S.Chand & Co. New Delhi, first Edition, 1985.
2. P.C.Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai & Sons, New Delhi, Fifteenth Edition,2009.
3. Fontana and Green, Corrosion Engineering, Tata McGraw Hill International Book Co. 2nd edition, 2005.
4. V.R.Gowariker, N.V.Viswanathan, Jayadev sreedhar, Polymer Science, New Age International publishers, (1986) Reprint 2010.

***List of Experiments*:** **30 Hours**

1. Estimation of hardness of water sample by EDTA method.
2. Determination of alkalinity of given water sample.
3. Determination of dissolved oxygen in a water sample.
4. Estimation of hydrochloric acid by pH titration.
5. Estimation of chloride ion in a given water sample.
6. Estimation of ferrous ion by potentiometric method.
7. Corrosion experiment-weight loss method.
8. Conductometric titration of strong acid with strong base.
9. Conductometric titration of mixture of acids with strong base.

CHY17R337	Organic Photochemistry and Pericyclic Reactions	L	T	P	C
		5	1	0	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level					
Course Category: Program Core	**Course Type:** Theory				

Objective(s) To understand the detailed mechanisms involved in photochemical and pericyclic reactions of organic molecules.

Course Outcome(s)

CO1 Understand the mechanisms of energy transfer and electron transfer processes

	involved in photochemical reactions of organic compounds.
CO2	Analyze the thermal and photochemical pathways of various pericyclic reactions.
CO3	Study the classification, modes and stereochemical aspects of electrocyclic reacitons.
CO4	Acquire the knowledge of thermal and photochemical cycloaddition reactions and their stereochemical aspects.
CO5	Understand the mechanisms of sigmatropic rearrangements and chelotropic Reactions.

Mapping of Course Outcome(s):

CO/PO	PO				
	1	**2**	**3**	**4**	**5**
CO1	L	M	L		
CO2		S		S	M
CO3	M		S		L
CO4		L		L	
CO5	S		M	M	S

Unit I Organic Photochemistry **15 Hours**

Introduction, definitions, importance. Electronic excitation and spin configurations – Jabolanski diagram. Energy transfer and electron transfer processes – quenching of excited states. Photochemistry of carbonyl compounds. Photochemistry of olefins, enones and dienones, photochemistry of aromatic molecules, molecular oxygen and organic photochemistry

Unit II General Aspects of Pericyclic Reactions **15 Hours**

General introduction, activation of chemical reactions. Thermal and photochemical methods, molecular orbitals of conjugated polyenes and their symmetry properties. Definition and classification of pericyclic reactions. Methods of analyzing pericyclic reactions.

Unit III Electrocyclic Reactions **15 Hours**

Introduction, definition and classification, Woodward- Hoffmann rules for electrocyclic reactions. Stereochemical aspects and modes of electrocyclic reactions. Analysis of electrocyclic reactions by various methods. Examples of electrocyclic reactions.

Unit IV Cycloaddition Reactions **15 Hours**

Woodward- Hoffmann rules for cycloaddition reactions. Stereochemical aspects and modes of cycloaddition reactions. Analysis of cycloaddition reactions by various methods. Examples of thermal and photochemical [2p+2p] cycloaddition reactions. Synthesis of cage type compounds using [2p+2p] cycloaddition reactions. Diels-Alder reaction, its variants and their synthetic utility. 1,3-Dipolar cycloaddition reactions. Higher order cycloaddition reactions.

Unit V Sigmatropic Rearrangements and Chelotropic Reactions **15 Hours**

Woodward Hoffmann rules for sigmatropic rearrangements. Sigmatropic

rearrangements – examples, Claisen and Cope rearrangements. [2,3]-sigmatropic rearrangements and higher order rearrangements. Chelotropic reactions - introduction, definition and classification. Ene reaction.

References

1. S. Sankararaman, Pericyclic Reactions – A textbook. Wiley-VCH, 2005.
2. I. Fleming, Pericyclic Reactions, Oxford University Press, 1999.
3. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry of Organic Compounds, University Science Books, 2010.

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