M. Sc. CHEMISTRY

Syllabus

(With effect from 2026-2027)

Program Code:116

DEPARTMENT OF CHEMISTRY
Bharathiar University
(A State University, Accredited with "A^{++}" Grade by NAAC and
15th Rank among Indian Universities by MHRD-NIRF)
Coimbatore 641 046, INDIA

BHARATHIAR UNIVERSITY: COIMBATORE- 641046

DEPARTMENT OF CHEMISTRY

MISSION

To transform the department into a world class institution and to provide excellent knowledgeable students to employers across the globe. The department of chemistry is one of the biggest departments of the University which was the first department to start functioning from 1973 in the erstwhile University of Madras Post Graduate Center at Coimbatore. The department comes under the School of Chemical Science.

Program Educational Objectives (PEOs)	
The **M. Sc. Chemistry**program aims that the graduates will become successful professional by demonstrating rational and analytical thinking abilities. The graduates will be mould to communicate efficiently and work in interdisciplinary research, and demonstrate scientific leadership in academia and industries.	
PEO1	Students learn the essentials of major fields in Chemistry namely Analytical, Organic, Inorganic and Physical Chemistry which would make them to understand the pivotal role played in the field of plant and animal biology, energy, materials, health sector and environment.
PEO2	Students will be encouraged to exchange their knowledge and skills for developing independent writing in their field of study
PEO3	Students will be allowed to design their own research project based on their firm theoretical understanding.
PEO4	Be motivated to prepare the students to pursue higher studies and research to meet out academic demands of the country.
PEO5	Have knowledge in wide range of chemistry techniques and application in scientific and engineering domains.

Program Specific Outcomes (PSOs)	
After the successful completion of **M.Sc. Chemistry**program, the students are expected to	
PSO1	To build the firm foundation in the fundamentals and correlate the application with the current developments in chemistry.
PSO2	To get sufficient expertise in the operational knowledge and laboratory skills in all major fields of chemistry.
PSO3	To emphasize on integrating various disciplines of Science and encourage for interdisciplinary approach.
PSO4	To acquire problem solving capacity, interpretation of results with the use of sophisticated instruments and devises new preparation techniques.
PSO5	To motivate the students to prepare for competitive examinations, job carriers and get trained for industrial entrepreneurship.
PSO6	To make current awareness on social, economic, and environmental problems facing globally

Program Outcomes (POs)	
On successful completion of the **M. Sc. Chemistry**program	
PO1	To equip students with advanced knowledge and insight in general and green chemistry
PO2	To equip students to meet current industrial need
PO3	To equip students with different types of problem solving related to academic and industrial domain
PO4	To enhance professional skills in chemistry by providing hands on training to operate the sophisticated instruments.
PO5	Acquire the knowledge on the role of chemistry in industries and to become entrepreneur
PO6	The students can understand the role of chemistry in day to day life.

BHARATHIAR UNIVERSITY: COIMBATORE 641 046

M. Sc. Chemistry Curriculum (University Department)

(For the students admitted during the academic year 2024– 2025 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
CHMA13A	**Organic Chemistry-I** Reaction Mechanisms and Aromaticity	**4**	**60**	**-**	**25**	**75**	**100**
CHMA13B	**Inorganic Chemistry-I** Coordination Chemistry	**4**	**60**	**-**	**25**	**75**	**100**
CHMA13C	**Physical Chemistry-I** Electrochemistry and Photochemistry	**4**	**60**	**-**	**25**	**75**	**100**
CHMA1EA	**Elective - I** Physical Methods in Chemistry	**4**	**60**	**-**	**25**	**75**	**100**
CHMA1EB	**Elective - II** Water Treatment, Fuels and Polymers	**4**	**60**	**-**	**25**	**75**	**100**
CHMA1EC	**Elective - III** Introduction to Industry 4.0	**4**	**60**		**25**	**75**	**100**
CHMA13P	**Practical - I** Organic Chemistry Practical	**4**	**-**	**60**	**25**	**75**	**100**
GS06	**Supportive - I** Chemistry in context	**2**	**25**		**12**	**38**	**50**
Total		**22**	**265**	**60**	**137**	**413**	**550**

SECOND SEMESTER

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
CHMA23A	**Organic Chemistry - II** Organic spectroscopy, Stereochemistry, Rearrangements, and Heterocyclic Chemistry	4	**60**		**25**	**75**	**100**
CHMA23B	**Inorganic Chemistry - II** Bioinorganic Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA23C	**Physical Chemistry - II** Quantum Chemistry and Group Theory	**4**	**60**		**25**	**75**	**100**
CHMA2EA	**Elective - IV** Inorganic Spectroscopy	**4**	**60**		**25**	**75**	**100**
CHMA2EB	**Elective - V** Energy, Diary and Drug Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA2EC	**Elective - VI** Artificial Intelligence	**4**	**60**		**25**	**75**	**100**
CHMA23P	**Practical - II** Inorganic Chemistry Practical	**4**	**-**	**60**	**25**	**75**	**100**
GS73	**Supportive - II** Chemistry in day to day life	**2**	**25**		**12**	**38**	**50**
Total		**22**	**265**	**60**	**137**	**413**	**550**

THIRD SEMESTER

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
CHMA33A	**Organic Chemistry - III** Modern Organic synthesis, Photochemistry, and Pericyclic reactions	**4**	**65**		**25**	**75**	**100**
CHMA33B	**Inorganic Chemistry - III** Solid State and Nuclear Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA33C	**Physical Chemistry - III** Chemical Kinetics and Surface Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA3EA	**Elective - VII** Bioorganic Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA3EB	**Elective - VIII** Industrial Organic Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA3EC	**Elective - IX** Data Analytics using R	**4**	**60**		**25**	**75**	**100**
CHMA33P	**Practical - III** Physical Chemistry Practical	**4**	**-**	**60**	**25**	**75**	**100**
GS	**Supportive - III** Chemistry of Environment	**2**	**25**		**12**	**38**	**50**
CHMA233886	Health and Wellness	**1**	**2**		**25**		**25**
Total		**23**	**267**	**60**	**162**	**413**	**575**

FOURTH SEMESTER

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
CHMA43A	**Organic Chemistry - IV** Name reactions, Alkaloids, Steroids, Functional group transformations, and Reagents in Organic Synthesis	**4**	**65**		**25**	**75**	**100**
CHMA43B	**Inorganic Chemistry - IV** Organometallic Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA43C	**Physical Chemistry - IV** Classical and Statistical Thermodynamics	**4**	**60**		**25**	**75**	**100**
CHMA4EA	**Elective - X** Analytical Chemistry	**4**	**60**		**25**	**75**	**100**
CHMA4LV	Project Work	**8**	**-**		**50**	**150**	**200**
	SWAYAM MOOCs Online 4 weeks course	**2**	**-**			**50**	**50**
Total		**26**	**245**		**150**	**500**	**650**
Grand Total		**93**	**1042**	**180**	**586**	**1739**	**2325**

ELECTIVE COURSES OFFERED					
Semester/ Code No.	**Subject**	**Credit**	**University examination**		
			Internal Mark	**External Mark**	**Total Mark**
CHMA1EA	Physical Methods in Chemistry	4	25	75	100
CHMA1EB	Water Treatment, Fuels and Polymers	4	25	75	100
CHMA1EC	Introduction to Industry 4.0	4	25	75	100
CHMA2EA	Inorganic Spectroscopy	4	25	75	100
CHMA2EB	Energy, Diary and Drug Chemistry	4	25	75	100
CHMA2EC	Artificial Intelligence	4	25	75	100
CHMA3EA	Bioorganic Chemistry	4	25	75	100
CHMA3EB	Industrial Organic Chemistry	4	25	75	100
CHMA3EC	Data Analytics Using R	4	25	75	100
CHMA4EA	Analytical Chemistry	4	25	75	100
SUPPORTIVE COURSES OFFERED TO OTHER DEPARTMENTS					
GS06	Chemistry in Context	2	12	38	50
GS73	Chemistry in Day-to-day life	2	12	38	50
GS	Chemistry of Environment	2	12	38	50

ADD ON COURSES

Value Added Courses (One course per year)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
CHMAV01	NMR Spectroscopy	2	20	10	-	-	50
CHMAV02	Analytical Instruments	2	20	10	-	-	50

Job Oriented Courses

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
CHMAJA1	Current Trends in Solar Cells	2	20	10	-	-	50
CHMAJA2	Overview of Energy Storage Devices	2	20	10	-	-	50

Health and Wellness

		Credits	Hours	Maximum Marks			
				Report	Attendance	Activity	Total
CHMA233886	Health and Wellness	1	2	40	20	40	100

Course code	CHMA13A	Organic Chemistry - I	L	T	P	C
Core		Reaction Mechanisms and Aromaticity	4	1	-	4
Pre-requisite		Chemical reactions and their mechanism	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To understand the reaction mechanism of the aliphatic, aromatic electrophilic and nucleophilic substitution reactions.
2. To know about the basic concept of aromaticity of the organic molecules.
3. To acquire basic knowledge about the addition and elimination reaction.
4. To understand the basic principles involving in the oxidation and reduction reactions.

Expected Course Outcomes:

On the successful completion of the course, student will be able to

1	To remember the basic principles of reaction mechanism involving to the organic reactions like electrophilic, nucleophilic, addition, elimination, oxidation, reduction reactions	**K1** **K2** **K3** **K4** **K5**
2	To understand the mechanistic pathway of the following reactions like electrophilic, nucleophilic, addition, elimination, oxidation, reduction reaction through the name reactions.	
3	To apply the reaction mechanism into the chemical reactions to predict the reaction pathway.	
4	To assessment about what kind of reaction mechanism involving into the chemical reaction during their project work.	
5	To learn about the concept of aromaticity in organic and inorganic compounds.	

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit 1	Aliphatic and aromatic nucleophilic substitution reactions	12hours

Bonding - structure and reactivity -hard and soft acid base theory (HSAB concept) - methods of determination and the study of reaction mechanisms.

S_N^1, S_N^2, S_N^i and neighbouring group participation mechanism- kinetics - effects of structure,

solvent, leaving and entering group - stereochemistry - hydrolysis of esters - Wurtz reaction - Claisen and Dieckmann condensation - Williamson ether synthesis.

Different mechanism of aromatic nucleophilic substitution - Ziegler alkylation, Chichibabin reaction, cine substitution, diazonium group as leaving group.

Unit 2	**Aliphatic and aromatic electrophilic substitution reactions**	**12 hours**

S_E^1 and S_E^2 reaction - mechanism and reactivity - typical reactions involving migration of double bond - keto-enol tautomerism - halogenation of carbonyl compounds - Stork enamine reactions - decarboxylation of aliphatic acids - Friedel Crafts acylation of olefinic carbon.

Aromatic electrophilic substitution - reactivity - orientation and mechanism – nitration, halogenation and sulphonation – Friedel-Crafts alkylation, arylation (Scholl reaction) and acylation - Jacobsen reaction - formylation with (i) disubstitutedformamides (Vilsmeyer - Haack reaction) (ii) zinc cyanide and HCl (Gattermann reaction) (iii) chloroform and KOH (Reimer-Tiemann reaction) - carboxylation with (i) carbonyl halides (ii) carbon dioxide (Kolbe Schmidt reaction) - amidation with isocyanate - hydroxyalkylation (hydroxyalkyl dehydrogenation)- cyclodehydration of aldehydes and ketones (Bradsher reaction and Bischler - Napieralskirection) - haloalkylation - aminoalkylation and amido alkylation - thioalkylation - acylation with nitriles (Hoesch reaction) - cyanation - hydroxylation.

Unit 3	**Aromaticity**	**12 hours**

Aromaticity- Concept of aromaticity - aromaticity of benzenoid and non benzenoid compounds - effect of aromaticity on bond lengths, resonance, resonance energies, and induced ring currents - Huckel's rule - structure and synthesis of azulenes, ferrocenes, sydnones, tropolones, fulvenes and annulenes.

Unit4	**Addition and elimination reactions**	**12 hours**

Addition to C-C and C-O multiple bonds - electrophilic, nucleophilic and free-radical additions - addition to conjugated systems - orientation - hydroboration - Michael condensation - 1,3 dipolar addition - Diels-Alder reaction - carbene addition to double bonds - hydration of olefins.

Mannich, Meerwein-Pondorf reduction, Grignard, Aldol, Claisen, Stobbe, Darzen, Wittig, Thorpe, benzoin condensation and Cannizarro reactions. Elimination reactions - E^1 and E^2 mechanism - orientation - Hofmann and Saytzeff rules - elimination *vs* substitution - Chugaev reaction - Hofmann degradation and Cope elimination - dehydration of alcohols - dehydrohalogenation - mechanism and orientation in pyrolytic elimination.

Unit 5	Oxidation and Reduction:	12 hours
Formation of C-C and C=C bonds by dehydrogenation - dehydrogenation by quinones, selenium dioxide (SeO_2), mercury(II) acetate ($Hg(OAc)_2$), and Lead(IV) acetate ($Pb(OAc)_4$)- formation of C-C bond in phenol coupling - acetylene coupling - allylic oxidation - oxidation of alcohols, glycols, halides and amines to aldehydes and ketones - ozonolysis - oxidation of olefinic double bonds and unsaturated carbonyl compounds - oxidative cleavage of the C-C bond - Sommelet reaction and selectivity in reduction - metal hydride reduction- Birch reduction - metal alkoxide reduction - reduction by dissolving metals - Clemmensen reduction - Wolf-Kishner reduction - metal ammonia reduction (Birch reduction) - reduction of nitro compounds - acyloin condensation - catenanes. Carbenes and nitrenes - structure and generation - addition reaction with alkenes - insertion reaction.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**Alicyclic compounds**	
Nomenclature, Cycloalkanes and cycloalkenes; Classification of monocyclic systems, Baeyer strain theory. Small and common rings, Conformational analysis. Medium-ring compounds, large ring compounds.		
	Total Lecture hours	**60 hours**

Text Book(s)

1.Jerry March, Advanced Organic Chemistry - Reactions, Mechanism and Structure, Wiley-Inter Science, 1992.

2. I. L. Finar, Organic Chemistry, Volume I, The fundamental principles, Sixth edition, Pearson education Ltd., 2014.

Reference Books

1	Thomas H. Lowry; Kathleen Schueller Richardson, Mechanism and Theory in Organic Chemistry, New York Harper & Row, 1990.
2	S. M. Mukherji and S. P. Singh, Reactions Mechanisms in Organic Chemistry, 1976 and Revised edition, Revised by: S.P. Singh & Om Prakash, Laxmi Publications Pvt. Ltd., 2015, New. 3rd Edition.
3	Raj K. Bansal Organic Chemistry Reaction Mechanisms, McGraw-Hill Publishing Company Ltd, 2006.
4	V. K. Ahluwalia, Organic Chemistry Fundamental concepts, Narosa Publishing House, 2013.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/101/104101115/

2	https://nptel.ac.in/courses/104/103/104103110/
3	https://nptel.ac.in/courses/104/101/104101005/
Course Designed By: Dr. T. Suresh and Dr. B. Murugesapandian	

Mapping with Programme Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**S**
CO2	**M**	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**	**S**
CO4	**M**	**S**	**S**	**S**	**S**	**M**
CO5	**M**	**S**	**S**	**S**	**M**	**S**

*S-Strong; M-Medium; L-Low

Course code	CHMA13B	Inorganic Chemistry - I	L	T	P	C
Core		Coordination Chemistry	4	1	0	4
Pre-requisite		Theories of chemical bonding	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. Learn about the various theories of complexes, basics of electronic spectroscopy of transition metal complexes, mode of coordination with various geometry
2. Learn about the important inorganic polymers and their applications.

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	Understand the various concepts of coordination chemistry and realize the importance of electronic spectroscopy and magnetic properties of coordination compounds.	**K2**
2	Gaining the knowledge on various types of inorganic reaction mechanism in different geometries.	**K2**
3	Acquiring knowledge on various types of electron transfer mechanism of metal complexes and their importance.	**K3**
4	Inferring various symmetries/geometries of coordination complexes and their isomerism and important applications of some inorganic polymers.	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Unit 1	Theories of coordination compounds	12 hours

18 electron rule - EAN rule - theories of coordination compounds - valence bond theory - crystal field theory - splitting of d orbitals in different symmetries - crystal field stabilization energy - factors affecting the magnitude of 10 Dq - evidence for crystal field stabilization - spectrochemical series - site selection in spinels - tetragonal distortion from octahedral symmetry - Jahn-Teller distortion - molecular orbital theory - octahedral complexes - tetrahedral and square planar complexes - π bonding and molecular orbital theory - experimental evidence for π bonding.

Unit2	**Electronic spectroscopy and Magnetic properties of coordination compounds**	**12 hours**
Term states of d^n ions - electronic spectra of coordination compounds - selection rules - band intensities and band widths - energy level diagrams of Orgel and Tanabe - Sugano - spectra of Ti^{3+}, V^{3+}, Ni^{2+}, Cr^{3+}, Co^{2+}, Cr^{2+} and Fe^{2+} - calculation of 10Dq and B for V^{3+} (oct) and Ni^{2+} (oct) complexes. Magnetic properties of coordination compounds - change in magnetic properties of complexes in terms of spin orbit coupling - temperature independent paramagnetism - spin cross over phenomena.		
Unit 3	**Substitution reactions of coordination compounds andredox reactions of octahedral**	**12 hours**
Substitution reactions in square planar complexes - the rate law for nucleophilic substitution in a square planar complex - the trans effect - theories of trans effect - mechanism of nucleophilic substitution in square planar complexes - kinetics of octahedral substitution - ligand field effects and reaction rates - mechanism of substitution in octahedral complexes - reaction rates influenced by acid and bases - racemisation and isomerisation - mechanisms of redox reactions - outer sphere mechanisms - excited state outer sphere electron transfer reactions - inner sphere mechanisms - mixed valent complexes.		
Unit4	**Coordination numbers and isomerism of coordination compounds**	**12hours**
Structure of coordination compounds with reference to the existence of various coordination numbers - complexes with coordination number two - complexes with coordination number three - complexes with coordination number four - tetrahedral and square planar complexes - complexes with coordination number five - regular trigonal bipyramidal and square pyramidal - site preference in trigonal bipyramidal complexes - site preference in square planar complexes - isomerism in five coordinate complexes - coordination number six - distortion from perfect octahedral symmerty - trigonal prism - geometrical isomerism in octahedral complexes - coordination number seven and eight.		
Unit5	**Inorganic chains, rings, cages and clusters**	**12hours**
Inorganic chains - rings - cages and clusters - catenation - heterocatenation - intercalation chemistry - one dimensional conductor - isopolyanions - heteropolyanions - borazines - phosphazenes - phosphazene polymers - ring compounds of sulphur and nitrogen - homocyclic inorganic systems - cages - boron cage compounds - metal clusters - dinuclear clusters - trinuclear		

clusters - tetranuclear clusters - hexanuclear clusters - structural prediction of organometallic clusters.

Self-Study (NOT FOR EXAMINATION)

Unit6	**Crystal field theory and magnetic properties of 'f' block elements**	

Crystal field splitting of 'f' orbitals- Molecular orbital diagram of lanthanides and actinides- electronic spectroscopy of 'f' block elements- term symbols for f^n configurations- electronic and magnetic properties of inner transition metals.

	Total Lecture hours	**60 hours**

Text book(s) :

1. Advanced Inorganic Chemistry - F. A. Cotton and G. Wilkinson.
2. Inorganic Chemistry - Principles of structure and reactivity, Fourth Edition J. E. Huheey, E. A. Keiter and R. L. Keiter - Addition Wesley Publishing Co, NY, 1993.
3. U.K.Malik, G.D.Tuli, and R.D. Madan, (2010). Selected Topics in Inorganic Chemistry, S. Chand Publication.

Reference Books

1	Gurdeep Raj. (2014). Advanced Inorganic Chemistry. 12th Edition. Geol Publishing House.
2	R.D. Madan. (2011). Advanced Inorganic Chemistry. 3rd Edition. S. Chand & company, New Delhi.
3	R. Gopalan. V. Ramalingam, (2001) Concise Coordination Chemistry, 3rd edition, Vikas Publishing House Pvt. Ltd.
4	Mechanism of Inorganic reactions - F. Basolo and R. G. Pearson
5	Inorganic Chemistry - R. B. Heslop and P. L. Robinson
6	Introduction to Ligand Fields - B. N. Figgis - Wiley Eastern Ltd, New Delhi, 1976

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/101/104101121/
2	https://nptel.ac.in/courses/104/101/104101090/

3	https://nptel.ac.in/courses/104/106/104106064/
Course Designed By: Dr. R. Prabhakaran	

Mapping with Programme outcomes

COs / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	S	S	S	S
CO2	M	S	S	M	S	S
CO3	M	M	S	M	M	S
CO4	S	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA13C	PHYSICAL CHEMISTRY – I	L	T	P	C
Core		Electrochemistry and Photochemistry	4	1	0	4
Pre-requisite		Basics of electrochemistry and photochemistry	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. To give a thorough introduction to the study of electrochemistry, photochemistry and nanoscience.
2. To learn the theories and basics of electrochemistry, photochemistry and various applications of electrochemical/photochemical and nanotechnological approaches.
3. To study the concepts and fundamentals of electrochemical and photochemical reactions.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Recollect the fundamentals of electrochemistry, photochemistry, nanoscience and nanotechnology.	**K1**
2	Understand the principles and applications of electrochemical cell models, batteries and photochemical reactions. To comprehend the mechanism of energy drive systems.	**K3**
3	Apply the various instrumental techniques related to electrochemical, photochemical and nanotechnology.	**K4**
4	Apply the fundamentals of electrochemistry, photochemistry in device fabrication	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	ELECTROCHEMISTRY - I	12hours

Ions in Solutions: Conductivity of solutions and their measurement - the Arrhenius ionisation theory - transport numbers and mobilities of ions - measurement of transport numbers - Hittorff method and moving boundary method - ionic activities and activity coefficients and their determination by various methods - Debye-Huckel-Onsager theory - ionic atmosphere - Debye-Huckel limiting law - Electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

Unit 2	**ELECTROCHEMISTRY - II**	**12hours**
Metal/Electrolyte Interface**:** Outer Helmholtz plane (OHP) and Inner Helmholtz plane (IHP) - potential profile across double layer region - potential difference across electrified interface - Structure of the double layer **-** Helmholtz-Perrin, Gouy-Chapman, and Stern models – Electrode kinetics - Butler-Volmer equation–one step one electron transfer kinetics - exchange current density - Tafel equation and plots - Polarizable and non-polarizable interfaces - Hydrogen overpotential – Theories of hydrogen overvoltage - Mechanism of hydrogen evolution reactions - Passivity – electrochemical corrosion and its protection.		
Unit3	**ELECTROCHEMISTRY - III**	**12hours**
Electrochemical Cells: Electromotive force - measurement of EMF - the potentiometer - the electrochemical potential - the cell EMF and the cell reaction - reversible cells - types of half cells - classification of cells - the standard EMF of a cell - standard electrode potentials - calculation of the EMF of a cell - Nernst equation and its limitations - calculation of solubility products - standard free energies and entropies of aqueous ions - electrode concentration cells - electrolyte concentration cells - cells with liquid junctions - oxidation - reduction reactions, measurement of pH, concentration cells with transference – Electrochemical energy systems - Li-ion batteries- Methanol Fuel cells.		
Unit 4	**PHOTOCHEMISTRY**	**12hours**
Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 and 2 – Physical properties of electronic excited state – Jablonski diagrams – Emission – Resonance emission – Selection rule – Fluorescence – Phosphorescence – Delayed fluorescence: E-Type and P-Type – Excimer and Exciplex complex formation – Stern-Volmer equation – Photosensitization and Chemiluminescence – Experimental techniques – Actinometry – Chemical actinometry – Biochemiluminescence – Photochromism – Photostabilization – Photosynthesis – PS I and PS II – Photochemical energy-storage reactions.		
Unit 5	**COLLOIDS AND CHEMISTRY IN NANOSCIENCE AND NANOTECHNOLOGY**	**12hours**
Types of solutions – Types of colloidal solutions – Preparation of colloidal solutions – Condensation methods – Disintegraton methods – Purification of colloidal solutions – Dialysis – Ultrafiltration – Characteristics of colloidal solutions – Emulsions – Micelles. Nanomaterials – Preparation: Plasma arcing - Chemical vapor deposition – Sol-gel method – silica gels – Zirconia and ytrrium gels – Aluminosilicate gels – Electrodeposition – Ball milling – Applications of nanomaterials – Machine tools – Batteries – High power magnets – Motor vehicles		

and aircraft – Medical applications.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**Recent trends in photochemical and electrochemical reactions**	
Alcohol based fuel cell reaction - solid oxides based fuel cell - Hydrogen and Oxygen evolution reaction (HER and OER) - 2D carbon materials - Boron Nitrides - g-C_3N_4 - Metal organic frameworks (MOF) - Layered double hydroxides (LDH) - Metal chalcogenides.		
	Total Lecture hours	**60 hours**

Text book(s)

1.Samuel Glasstone, "An Introduction to Electrochemistry", Maurice Press, 2007.

2. Atkins P.W., "Physical Chemistry", Oxford University Press, 8th Ed., 2006.

3. Rohatgi Mukherjee K.K.,"Fundamentals of photochemistry", New Age International Pvt. Ltd., New Delhi, 2009.

Reference Books

1	Gordon M.Barrow-Physical Chemistry,Mc Graw Hill Publishing Company Ltd, 2007.
2	John O'M. Bockris, Amulya K. N. Reddy, "Modern Electrochemistry", Vol. I and II, Plenum Publishing, 2008
3	Charles Kutal, Journal of Chemical Education 60 (1983) 882-887.
4	Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse, "Nanotechnology – Basic Science and Emergin Technologies", Chapman & Hall (CRC), 2004.
5	Evans A. Monyoncho, Tom K. Woo and Elena A. Baranova, Ethanol electrooxidation reaction in alkaline media for direct ethanol fuel cells, *Electrochemistry: 15,* (**2018**) 1-57.
6	Neelima Mahato, Amitava Banerjee, Alka Gupta, Shobit Omar, Kantesh Balani, Progress in material selection for solid oxide fuel cell technology: A review, *Progress in Materials Science* 72 **(2015)** 141–337
7	Sustainable carbon materials, *Chem. Soc. Rev* (**2014)** DOI: 10.1039/c4cs00232f
8	Mohadeseh Safaei, Mohammad Mehdi Foroughi, Nasser Ebrahimpoor, Shohreh Jahani, Ali Omidi, Mehrdad Khatami, A review on metal-organic frameworks: Synthesis and

	applications, *Trends in Analytical Chemistry*, 118 **(2019)** 401-425.
9	Qiang Wang and Dermot O'Hare, Recent Advances in the Synthesis and Application of Layered Double Hydroxide (LDH) Nanosheets, *Chem. Rev.*, 112 (**2012)** 4124−4155.
10	Min-Rui Gao, Yun-Fei Xu, Jun Jiang and Shu-Hong Yu, Nanostructured metal chalcogenides: synthesis, modification, and applications in energy conversion and storage devices, *Chem. Soc. Rev.*, 42 **(2013)** 2986.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.	
1	https://nptel.ac.in/courses/104/106/104106105
2	https://nptel.ac.in/courses/103/106/105106204
Course Designed By: Dr.T.Selvaraju	

Mapping with Programme outcomes

COs / **POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	M	S	S	M	S
CO2	S	S	S	M	M	S
CO3	M	S	S	M	M	S
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA1EA	Elective - I	L	T	P	C
Elective		PHYSICAL METHODS IN CHEMISTRY	4	1	0	4
Pre-requisite		Fundamentals of the electromagnetic spectrum	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. To study the principle and mechanism of different types of molecular spectroscopy.
2. To acquire basic knowledge about the activity of molecules using various spectroscopic techniques.
3. To study the basic principles of radiation chemistry and basic knowledge about various surface morphology analysis techniques.
4. To understand the working principle of the different instruments and analysis the surface morphologies of the various materials.

Expected Course Outcomes

On the successful completion of the course, students will be able to

1	To understand the fundamental concepts and applications of various analytical techniques.	**K1**
2	To acquire intense knowledge about the basic principles, instrumentation, and applications of Rotational, Vibrational, and Raman spectroscopy.	**K2**
3	To apply the knowledge of electronic absorption spectroscopy and predict the absorption wavelength of various organic molecules.	**K3**
4	To gain in-depth knowledge of concepts in radiation chemistry. Understand the surface morphology (particle shape and size) characterization of materials using various advanced instrumentation techniques.	**K4**
5	To interpret the data for well-known compounds, this will be helpful in predicting the unknown molecules.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	**ROTATIONAL SPECTROSCOPY**	**12 hours**
General introduction to electromagnetic spectrum – The rotation of molecules – Classification of rotors – Rigid rotors, Non-rigid rotors – Effect of isotopic substitution on the transition frequencies – diatomic and polyatomic molecules – Relative intensities of spectral lines – stark effect – Nuclear and electron spin interaction – Instrumentation – Chemical analysis by microwave spectroscopy.		
Unit 2	**VIBRATIONAL SPECTROSCOPY**	**12 hours**
Simple harmonic oscillator – Vibrational motion of a diatomic molecule – Selection rule – Zero-point energy – Force constant and bond strengths – Hot bands – Anharmonic oscillator - Vibrations of polyatomic molecules – Fundamental vibrations and overtones –Vibrational-rotational spectra of a diatomic molecule – Vibrations of polyatomic molecules - Instrumentation – Sampling techniques - Factors influencing vibrational frequencies - Application to organic and inorganic compounds - Finger print region - Identification of functional groups - Simple problems in functional group identification using IR spectrum.		
Unit 3	**RAMAN SPECTROSCOPY AND ELECTRONIC SPECTROSCOPY OF ATOMS**	**12 hours**
Pure rotational Raman spectra – Vibrational Raman spectra – selection rule - Polarization of light and the Raman effect – Structural determination from Raman spectroscopy – Techniques and Instrumentation. Structure of atoms – Electronic angular momentum – many-electron atoms – photoelectron spectroscopy and X-ray fluorescence spectroscopy – Zeeman effect – Influence of nuclear spin – problems.		
Unit 4	**ULTRAVIOLET AND VISIBLE SPECTROSCOPY**	**11 hours**
Electronic spectroscopy of molecules – Electronic spectra of diatomic molecules - Physical principles – Chromophores and auxochromes – Laws of absorption – Absorption transitions – Instrumentation – Solvent effects – Applications of UV spectroscopy – Effects of conjugation – Woodward-Fieser rules – α, β-Unsaturated carbonyl compounds, dienes, trienes and polyenes – Aromatic systems with extended conjugation – Heteroaromatic compounds – Simple problems – Absorption spectra of charge transfer complexes.		

Unit 5	RADIATION CHEMISTRY AND MORPHOLOGICAL STUDIES	11 hours
Radiation chemistry: Source of high energy – interaction of high energy radiation with matter – primary and secondary process – G-value – radiolysis of water – reactions of hydrated electrons OH and H radicals – experimental techniques (Dosimetry). Introduction to Surface characterization methods – AFM, SEM, FE-SEM, HR-TEM, STEM - Sample preparation for characterization only.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**ARTIFICIAL INTELLIGENCE IN CHEMICAL SPECTROSCOPY**	
Python programming and Google Colab for AI and machine learning model development – AI-assisted analysis of rotational, vibrational, IR, Raman, and UV–Visible spectra using tools such as ChatGPT, Gemini, Claude, and Grok.		
	Total Lecture hours	**60 hours**

Text book(s):

1. Donald L. Pavia, Gary M. Lampman and George S. Kriz, Jr - Introduction to Spectroscopy: A Guide for students of organic chemistry.

2. Banwell C. N., "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill Publishing Company Limited, New Delhi, 4th Edition, 2004.

3. Raymond Chang - Basic principles of spectroscopy, McGraw-Hill, 1971.

Reference Books

1	D.H.Williams-Ian Fleming, Spectroscopic Methods in Organic Chemistry,Mc Graw Hill Publishing Company Ltd, 2006.
2	G. Friedlander, J.W. Kennedy and J.M. Miller, Nuclear and Radiochemistry, Wiley, 1964.
3	Zhou W, Wang Z. L, "Scanning Microscopy for Nanotechnology: Techniques and Applications", Springer, New York, USA, 2006.
4	Russel, W. B., Saville, D. A., and Schowalter, W. R. (1989) Colloidal Dispersions. Cambridge University Press Cambridge.
5	Elimelech, M., Gregory, J., Jia, X., and Williams, R. A. (1995) Particle Deposition and Aggregation: Measurement, Modeling, and Simulation. Butterworth-Heinemann Ltd.

	Oxford.
6	Israelachvili, J. (2011) Intermolecular and Surface Forces, 3 ed. Academic Press London.
7	Muhammad Raza Shah, Muhammad Imran and Shafi Ullah (2017), Lipid-Based Nanocarriers for Drug Delivery and Diagnosis, Elsevier Publication.
8	Thermal and Rheological Measurement Techniques for Nanomaterials Characterization - Editors: Sabu Thomas, Raju Thomas, Ajesh K. Zachariah, Raghvendra Mishra, Vol. 3 , 1st edition, (2017) Chapter – 1, (pp.1-36) Elsevier Publications.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/106/104106122/
2	https://nptel.ac.in/courses/103/108/103108124/
3	https://nptel.ac.in/courses/112/106/112106155/

Course Designed By: Dr. S.N. Karthick

Mapping with Programme outcomes

COs / POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	M	M	S	S	M
CO2	M	M	S	S	M	S
CO3	S	S	M	S	S	M
CO4	M	M	M	S	M	M

*S-Strong; M-Medium; L-Low

Course code	CHMA1EB	Elective– II	L	T	P	C
Elective		Water Treatment, Fuels and Polymers	4	1		4
Pre-requisite		Awareness on Environmental issues	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. To teach the students the essential role of water in industries
2. To teach the importance of various types of fuels and their applications
3. To create awareness on environmental pollution
4. To impart the knowledge on the chemistry of polymers and its applications

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	Understood the properties of water and quality measurements	**K1**
2	Learnt about the various water treatment techniques to get drinkable water	**K2**
3	To evolve strategy for conservation of energy and alternative energy resources	**K4**
4	To understand the toxicity and factors responsible for the air pollution	**K4**
5	Understood the importance of polymers and ways to minimize the usage of plastics and wastage disposal	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Water Treatment	12hours

Sources of water – Molecular structure and physical properties – Hydrogen Bonding – Water as a solvent – Quality characteristics of water: total acidity and alkalinity, hardness of water – methods of determination of hardness, total solids, disadvantages of using hard water - Comparative account on physical and chemical properties of H_2O and D_2O.

Unit 2	**Water conditioning**	**12hours**
Softening of water: Desalination, Clark's process, lime-soda process, ion-exchange process; demineralization of water - Treatment of water: sterilization, flocculation, Industrial treatment – Treatment of wastes or effluents with organic and inorganic impurities, sewage and sewage treatment; Biochemical oxygen demand (BOD), chemical oxygen demand (COD)		
Unit 3	**Fuels**	**12hours**
Introduction – definition, calorific value, determination of calorific value- Classification of fuels – solid, liquid and gaseous fuels, Fossil fuels, Rocket fuels and nuclear fuels - advantages and disadvantages of solid fuels over liquid and gaseous fuels. Energy – unit of energy, sources of energy, renewable and non-renewable, conventional and non-conventional energies. Solar energy – solar photovoltaic cells and applications. Energy storage**:** Batteries and fuel cells – dry cell (primary cell), lead –acid battery (secondary cell), hydrogen-oxygen fuel cell, advantages of fuel cell. Future options for energy – Bio conversion and advantages.		
Unit 4	**Environmental Pollution**	**12hours**
Components of environment – Factors affecting environment - Environmental pollution – Definition, pollutants, classification of pollutants - Types of pollution: air, water soil, thermal, radioactive and noise pollutions - Prevention and control of pollutions.		
Unit 5	**Plastics (High Polymers)**	**12hours**
Introduction, classification, difference between thermosetting and thermoplastics- Effect of polymer structure on properties - Formation of plastics : copolymerization, difference between addition and condensation polymerization – Properties and uses of plastics – Moulding of plastics - Commercial resins and plastics: bakelite, urea-formaldehyde, melamine-formaldehyde, epoxy, acrylic and silicon resins, polythene, PVA, PVC, cellulose, cellulose nitrate and acetate- Disposing of plastics : incineration, biodegradation, recycling and source reduction.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**Indian Medicinal Plants**	
Hibisous Rosa Sinesis: Adathoda vasica: Ocimum Sanctum: Mangifera Indica: Azadirachta Indica: Phyllanthys Niruri: Solanum Trolobatum: Grasses; Green		
	Total Lecture hours	**60hours**

Text Book(s):

1. Industrial Chemistry (Including Chemical Engineering), B.K.Sharma (10th Edition, 1999)

2. Polymer science By V.R. Gowariker, N.V.Viswanathan and J.Sreedhar,John Wiley & sons,1986.

Reference Books

1	Industrial Chemistry (Including Chemical Engineering) -- B.K.Sharma (10th Edition, 1999)
2	Outlines of Chemical Technology – For the 21st Century – M.Gopala Rao & Marshall Sittig (3rd Edition, 1997)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/105/104105103
2	https://nptel.ac.in/courses/113/104/113104008

Course Designed By:Dr. M. Ilanchelian

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	H	S	S	M	S
CO2	S	S	S	S	H	S
CO3	S	S	S	H	M	S
CO4	S	S	S	M	M	S
CO5	S	S	S	H	M	S

***S-Strong; M-Medium; L-Low**

Course code	CHMA1EC	Elective - III	L	T	P	C
Elective		Introduction to Industry 4.0	4	1	0	4
Pre-requisite		Fundamentals on emerging Technology in computer science	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. At the end of completing this course, students will have knowledge on Industry 4.0, need for digital transformation and the following Industry 4.0 tools

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	To understand the concept of Industry 4.0	K2
2	To apply the concept of Artificial Intelligence	K3
3	To analyze the Big Data and IoT	K4
4	To evaluate the Applications and Tools of Industry 4.0	K4
5	To create the awareness regarding the job 2030	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	Industry 4.0	12 hours

Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles -Technologies of Industry 4.0 – Big Data – Artificial Intelligence (AI) – Industrial Internet of Things - Cyber Security – Cloud – Augmented Reality

Unit 2	Artificial Intelligence	12 hours

Artificial Intelligence: Artificial Intelligence (AI) – What and Why? - History of AI - Foundations of AI -The AI - environment - Societal Influences of AI – Application Domains and Tools - Associated Technologies of AI - Future Prospects of AI – Challenges of AI.

Unit 3	Big Data and IoT	12 hours

Big Data : Evolution - Data Evolution - Data : Terminologies - Big Data Definitions - Essential of Big

Data in Industry 4.0 - Big Data Merits and Advantages - Big Data Components : Big Data Characteristics - Big Data Processing Frameworks - Big Data Applications - Big Data Tools - Big Data Domain Stack : Big Data in Data Science – Big Data in IoT - Big Data in Machine Learning - Big Data in Databases - Big Data Use cases : Big Data in Social Causes - Big Data for Industry -Big Data Roles and Skills -Big Data Roles - Learning Platforms; Internet of Things (IoT) : Introduction to IoT – Architecture of IoT - Technologies for IoT - Developing IoT Applications - Applications of IoT - Security in IoT.		
Unit4	**Applications and Tools of Industry 4.0**	**12hours**
Applications of IoT – Manufacturing – Healthcare – Education – Aerospace and Defense – Agriculture – Transportations and Logistics – Impact of Industry 4.0 on Society: Impact on Business, Government, People. Tools for Artificial Intelligence, Big Data and Data Analytics, Virtual Reality, Augmented Reality, IoT, Robotics.		
Unit 5	**Jobs 2030**	**12hours**
Industry 4.0 – Education 4.0 – Curriculum 4.0 – Faculty 4.0 – Skills required for Future - Tools for Education – Artificial Intelligence Jobs in 2030 – Jobs 2030 - Framework for aligning Education with Industry 4.0.		
	Total Lecture hours	**60hours**

Text Book

Reference Books

1	P. Kaliraj, T. Devi, Higher Education for Industry 4.0 and Transformation to Education 5.0, 2020

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/106/102/106102220
2	https://nptel.ac.in/courses/106/104/106104189

Course Designed By: Prof. P. Kaliraj

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	M	S
CO2	S	M	M	S	S	M
CO3	S	S	S	S	M	S
CO4	M	M	S	S	S	S

CO5	S	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code	**CHMA13P**	**PRACTICAL- I**	**L**	**T**	**P**	**C**
Core		**ORGANIC CHEMISTRY PRACTICAL**	**0**	**0**	**6**	**4**
Pre-requisite		**Knowledge about the properties and preparation of an organic compounds**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are

1. To carry out the separation of organic components from the binarymixture.
2. To quantify the organic compound using a substitutionreaction.
3. To prepare simple organic compounds using single and double stage preparations
4. To know about their prepared compounds' purification and recrystallization techniques.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Able to determine the presence of functional groups in a given unknown organic compound	**K2**
2	To know the protocol for the preparation of an organic compound by single and double stage preparation, which meets the industrial standards	**K3**
3	To understand the basic reaction conditions, such as solubility, hydrolysis, acetylation, bromination, and nitration, and prepare suitable derivatives	**K4**
4	Imbibing professional ethics in the synthesis of new compounds	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

	Qualitative analysis	**15 hours**

Analysis of Binary Mixtures - Separation and Characterization of the Components.

	Quantitative analysis	**15 hours**

Estimation of Phenol, Aniline, and Glucose		
	Single stage preparation	**15 hours**
(i) Benzoic acid from Ethylbenzoate (ii) Acetanilide fromAniline (iii) Acetylsalicylic acid from Salicylicacid (iv) *p*-Bromoacetanilide fromAcetanilide (v) Picric acid fromPhenol		
	Double stage preparation	**15 hours**
(i) 1,3,5-Tribromobenzene from Aniline (ii) *p*-Nitroaniline fromAcetanilide		
	Total hours	**60 hours**

Text Book

1. N. S. Gnanaprakasam, G. Ramamurthy, Organic Chemistry: Lab Manual, Viswanathan, S., Printers & Publishers Pvt Ltd, 2009.
2. V. Venkateswaran, R. Veeraswamy, A.R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons; 2nd Edn, 2012.

Reference Books

1	Vogel'sTextbookofPractical Organic Chemistry,5th Edn,PrenticeHall,2008.
2	Raj K Bansal, Laboratory Manual of Organic Chemistry, 5th Edn, New Age International (p) Ltd, 2008.

Course Designed By: Dr. A. Kannan

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	M	S
CO2	S	M	M	S	S	M
CO3	S	S	S	S	M	S
CO4	M	M	S	S	S	S

CO5	S	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code	**GS06**	**Supportive - I**	**L**	**T**	**P**	**C**
Supportive		**CHEMISTRY IN CONTEXT**	**2**	**0**	**0**	**2**
Pre-requisite		**Learn on Environmental Pollution**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to

1. To learn the principles of Green chemistry
2. To recall the factors involved in the air pollution which affects the environment
3. To Enable the students to know about the various energy resources
4. To understand the principles of preparation properties and applications of plastic

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	To understand the toxicity and factors responsible for the air pollution	**K2**
2	To realize the impact of manmade pollution on ecosystem	**K4**
3	To evolve strategy for conservation of energy and alternative energy resources	**K3**
4	To understood the toxicity of plastics and minimize the usage of plastics	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	**Air**	**6hours**

Air- Introduction- Definition- Composition of air- Air pollution-Definition-Air pollutants-Types of Air pollution - Causes of Air pollution on human health-Prevention of Air pollution

Unit 2	**Water**	**6 hours**

Water-Introduction-Definition-Sources of water-Types of water-Water quality parameters-Water pollution- Definition-Types of Water pollution- Causes of Water pollution on human health-Prevention of Water pollution.		
Unit 3	**Energy**	**6 hours**
Energy - Introduction- Definition-Sources of energy- Types of energy- Renewable energy sources-Non-renewable energy sources- Nuclear energy-Applications.		
Unit 4	**Polymers**	**7 hours**
Polymers –Introduction-Definition- Types of polymers based on physical property- Characteristics of polymers- polyethylene – PVC- Synthetic fibres –Definition, Nylon 66, and Terylene.		
	Total Lecture hours	**25 hours**

Text Book

1. Environmental Chemistry, A.K.De, 8th edition, New age international publishers.

Reference Books

1	Fundamental concepts of applied Chemistry, Jayashree Ghosh, 1st edition, S.Chand and company.
2	Chemistry in context applying chemistry to society-, Lucy Pryde Eubanks, Catherine H. Middlecamp, Norbert J. Pienta, Carl E. Heltzel, Gabriela C. Weaver, 5th edition, McGraw Hill.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/109/101/109101171
2	https://nptel.ac.in/courses/104/105/104105124

Course Designed By:Dr. M.Ilanchelian

Mapping with Programme outcomes

POS / COS	PO1	PO2	PO3	PO4	PO5	PO 6
CO1	M	H	S	S	S	H
CO2	S	S	S	S	S	S

CO3	M	S	S	H	S	S
CO4	S	S	S	H	S	S

S-Strong; H-High; M-Medium; L-Low

Course code	**CHMA23A**	**Organic Chemistry – II**	**L**	**T**	**P**	**C**
Core		Organic Spectroscopy, Stereochemistry, Rearrangements, and Heterocyclic Chemistry	**4**	**1**		**4**
Pre-requisite		**Basic concepts of spectroscopy, organic reactions, and stereochemistry**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are

1. To understand the basic principles of NMR and Mass spectroscopy and their application in organicmolecules.
2. To understand the basic concept of conformational analysis and stereochemistry.
3. To know about the principles of molecular rearrangements, it is essentially involved in the namereactions.
4. To acquire basic knowledge about the heterocyclic chemistry involved in various natural products.

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	To remember the basic principles of Mass and NMR spectroscopy and the stereochemistry of organic and heterocyclic molecules	**K1**
2	To understand the concept of conformational analysis and the stereochemistry of organic molecules. To get the basic idea about heterocyclic chemistry in various natural products and molecular rearrangements involved in organic reactions.	**K2**
3	To apply the concept of NMR, Mass spectroscopy in organic molecules to determine their structures, and the concept of stereochemistry in optically active organic molecules and heterocyclic molecules	**K3**
4	To analyze the geometry of the molecules as well as the stereochemistry of the organic molecules. To analyze organic molecules using organic spectroscopic methods to determine the organic structure.	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Nuclear Magnetic Resonance Spectroscopy	12 hours

^{1}H-NMR spectroscopy: Magnetic properties of nuclei -Chemical shifts – spin-spin coupling – coupling constant – analysis of first order spectra – spin-spin splitting – shielding, deshielding, anisotropic effect – AX, AX_3, A_2X_3, AMX, ABX, AB_2, A_2B_2 systems – Karplus equation – factors influencing the coupling constant (J) – influence of stereochemical factors on chemical shift of protons – Protons-deuterium exchange phenomenon, chemical spin decoupling of rapidly exchangeable protons (-OH, -SH, -COOH, -NH, -NH_2) – non first order spectra – simplification of complex spectra – double resonance – shift reagents – NOE and its applications. ^{13}C-NMR spectroscopy: low natural abundance – ^{1}H decoupling – off-resonance study - effect of alkyl and halogen substitution, hybridization effects. APT, DEPT, INEPT, and INADEQUATE techniques.

Unit 2	Mass Spectrometry	12 hours

Instrumentation - methods of ionization - EI, CI, SIMS, FAB, MALDI, and ESI. HRMS- Mass analyzer - magnetic and electrostatic sector, quadrupole, and time of flight.Presentation and analysis of spectra - determination of molecular formula - nitrogen rule - isotopic abundance analysis - metastable ions and peaks - molecular ion peak. Fragmentation process - even and odd electron ions - scission with rearrangement - retroDiels-Alder rearrangement - McLafferty rearrangement - double band and/or) ring equivalents implied from a formula. Fragmentation associated with functional groups - aromatic and aliphatic hydrocarbons - halides - alcohols - Phenols - thiols- ethers - sulphides - carbonyl compounds - aldehydes - ketones - esters - carboxylic acids - acid chlorides - amines - amides - nitriles - nitro compounds - aromatic compounds - eliminations due to ortho group.

Unit 3	Conformational Analysis and Stereochemistry	12 hours

Introduction to molecular symmetry and chirality – axis, plane, center, and alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, and S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. D, L system, Cram's and Prelog's rules: R, S and E, Z notations, proR, proS, si phase and re phase, Cahn-Ingold-Prelog rules, absolute and relative configurations. Topicity and prostereoisomerism, chiral shift reagents, and chiral solvating reagents. conformational analysis of acyclic systems - carbohydrates - cyclohexanes – decalins - perhydrophenantharene - spiranes-allenes and biphenyls. Asymmetric Synthesis-Introduction-methods of asymmetric synthesis-auxiliary controlled methods-reagent controlled methods-catalyst controlled methods.

Unit 4	**Molecular Rearrangements**	**12 hours**
Molecular rearrangements - intramolecular rearrangements - 1,2-shifts in carbonium ions - Wagner-Meerwein and related rearrangements - Demjanov rearrangement - migration to carbonyl carbon - Neber rearrangement – Benzilic acid - Baeyer-Villiger rearrangement - rearrangements to electron-deficient nitrogen and oxygen - Dienone-Phenol - Favorskii - Wolff - Benzidine - Claisen - Cope rearrangements, Ylides: Stevens-Wittig-Sommelet–Hauser - Pummerer rearrangements - non-cyclic rearrangements - Chapman and Wallach rearrangements.		
Unit 5	**Heterocyclic compounds**	**12 hours**
Structure - synthesis and reactions of the following systems a) small ring Heterocycles - Aziridine, Oxirane, Thiirane, Azetidine, Oxetane, Thietane, Pyrrole, Furan, Thiophene, and Pyridine. b) Benzo fused Heterocycles – Indole, Benzofurans, Benzothiophenes, Quinolines, Benzothiazole, Benzoxazole, Benzopyrones, Carbazole.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**Introduction to AI in Chemistry**	
Basics of AI and ML - AI Applications in Physico-organic, and analytical chemistry - Tools and platforms (Python, RDKit, scikit-learn, TensorFlow, Chemprop). Molecular Descriptors and Fingerprints - SMILES notation, InChI, and molecular representations - Feature extraction using RDKit - Morgan fingerprints, MACCS keys. Supervised Learning in Chemistry - Regression and classification models - QSAR/QSPR models - Cross-validation and model evaluation. AI in Drug Discovery - Virtual screening - ADMET prediction.		
	Total Lecture hours	**60 hours**

Text Book(s)

1. Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James R. Vyvyan, Introduction to Spectroscopy, 5th Ed., Cengage India Private Limited, 2015.

2. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 11th Ed., New Age International Private Ltd,2022.

3. Jerry March, Advanced Organic Chemistry - Reactions, Mechanism and Structure, 4th Ed., Wiley, 2006.

4. R. K. Bansal, Heterocyclic Chemistry, 5th Ed., New Age International Private Ltd,2017.

Reference Books	
1	R. M. Silverstein, Francis X. Webster, David J. Kiemle, and David L. Bryce, Spectroscopic identification of organic compounds, 8th Ed., Wiley; 2015.
2	William Kemp - Organic spectroscopy, 3rd Ed., Palgrave Publishers Ltd., 1991.
3	E. L. Eliel, Stereochemistry of carbon compounds, McGraw-Hill, 1962.
4	Ernest L. Eliel and Samuel H. Wilen, Stereochemistry of Organic Compounds, 1st Ed., Wiley, 2008.
5	S. N.Sanyal, Reactions, Rearrangements and Reagents, 4th Ed., Bharati Bhawan, 2003.
6	John A. Joule, K. Mills, Heterocyclic Chemistry, 5th Ed., Wiley, 2010.
7	Thomas L. Gilchrist, Heterocyclic Chemistry, 3rd Ed.,Pearson Education India, 2005.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://archive.nptel.ac.in/courses/104/108/104108078/
2	https://nptel.ac.in/courses/102101050
3	https://archive.nptel.ac.in/courses/104/106/104106127/
4	https://nptel.ac.in/courses/104105462
5	https://archive.nptel.ac.in/courses/104/105/104105034/
Course Designed By: Dr. A. Kannan	

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	S	S	S	S
CO2	M	M	S	S	S	M
CO3	S	S	S	S	S	S
CO4	M	M	S	S	S	M

*S-Strong; M-Medium; L-Low

Course code	CHMA23B	INORGANIC CHEMISTRY- II	L	T	P	C
Core		INORGANIC CHEMISTRY- II (Bioinorganic Chemistry)	4	1		4
Pre-requisite		Basic Notions of inorganic chemistry in biological systems	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. To understand the key role of various metal ion in the living systems.
2. To acquire basic knowledge about the structure and functions of metalloenzymes.
3. To gain insight into the small molecules transport, binding and activation mechanisms involving metalloenzymes
4. To know about the mechanism of binding interactions of metal complexes with bio-molecules and metal-based drug action.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Understand the key function of metal ions such as manganese, iron, cobalt, nickel, copper, zinc, molybdenum etc. in biological system, in particular in metalloenzymes.	**K1, K2, K3, K4, K5**
2	Acquire intense knowledge about various biological roles such as metal ion transport and storage, electron- and proton transfer, O_2 transport, hydrolysis, etc. taking place at the active site of metalloproteins.	**K1, K2, K3, K4, K5**
3	Gain knowledge about the medically-important topics such as i) metal in medicine, ii) interaction of metal ions with biomolecules, iii) the toxicity of metal ions, and use of iv) ruthenium and platinum complexes in cancer therapy. This would motivate the students to pursue their research in the field of medicinal chemistry.	**K1, K2, K3, K4, K5**
4	Equip the student to answer the bioinorganic chemistry related questions which are frequently aroused in competitive examinations.	**K4, K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	**Metals in Biology**	**12 hours**
Metals and Non-metals in biological systems - Essential and trace elements - Role of different metal ions in biological systems - Storage and transport mechanism: Sodium-Potassium pump - Calcium ATPase pump - Ferritin - Hemosiderin - Transferrin –Siderophores: enterobactin, ferrioxime, ferrichrome–Ceruloplasmin, Metallothionein - Blue copper proteins - Catecholase - Photosynthesis: Chlorophyll andPhotosystem (PS-I and PS-II) - Structure-function relationship.		
Unit2	**Structure and Function of Various Metalloenzymes**	**12 hours**
Metalloenzymes - Definition - Examples - Active site structure and mechanism of action of - Carboxy peptidase-A, Carbonic anhydrase and Thermolysin - Structure and function of Galactose oxidase, Amine oxidase, Dopamine β-hydroxylase – Ascorbate oxidase -Superoxide dismutase (SOD) (Fe-SOD, Mn-SOD, Cu-Zn couple SOD and Ni-SOD), Peroxidase and catalase - Xanthine oxidase, Nitrogenase, Hydrogenase, Urease		
Unit3	**Heme and Non-heme Metalloenzymes**	**12 hours**
Phorphyrin system - Structure and functions of hemoglobin and myoglobin, hemocyanin – hemerythrin - Dioxygen binding, transport and utilization - Synthetic oxygen carriers - Vitamin B_{12} and B_{12} co-enzyme - Non-heme iron-sulphur proteins: rubredoxin andferridoxins- Cytochrome a, b, c - Cytochrome P450, Cytochrome c oxidase - Methane monooxygenases (sMMO, pMMO).		
Unit4	**Metals in Medicine**	**12 hours**
Binding of metal ions and complexes to biomolecules, Types of binding - Nucleic acid structures - Fundamental interactions with nucleic acids - Binding interactions oftris-phenanthroline metal complexes with DNA - Techniques to monitor binding (electronic absorption, fluorescence and circular dichroic spectral techniques, electrochemical behaviour, viscosity measurement and ploarimetry). Chemotherapy - Radio diagnostic agents - MRI scanning - Chelating Agents (with special reference to EDTA) and therapy based on in vivo chelation of radio nucleotides - Dosage and toxicity.		
Unit5	**Drug Discovery and Design**	**12 hours**
Drug discovery and design - Therapeutic index and chemotherapeutic index - Structure -activity relationship - Factors governing drug design - Computer aided drug design - Bleomycin –		

Doxorubicin - Cancer chemotherapy - Bioinorganic chemistry of platinum and ruthenium anticancer drugs - Mechanism of action of cisplatin - Clinical trials and their significance - Applications of Coordination complexes in medicine.		
Unit6	**Metal Based Drugs**	
Gold-based drugs -treatment of cancer and rheumatoid - mechanism of interaction. Lithium containing drugs- uses - mode of interaction - side effects. Silver based drugs -anti-bacterial - antifungal agent - anticancer agent. Bismuth containing drugs - the treatment of acidity and related diseases.		
	Total Lecture hours	**60 hours**

Text Book(s):

1**.** Dr Asim K Dass, Bioinorganic Chemistry 2007, Books and Allied (P) Limited.

2. Bioinorganic chemistry: Inorganic Elements in the chemistry of life, 2nd edition, Wolfgang Kaim, Brigitte schwederski, Axel klein.

Reference Books

1	I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, Bioinorganic Chemistry; University Science Books.
2	J. E. Huheey, E. A. Kieter, and R. L. Keiter, Inorganic Chemistry, 4th Edition, Addision Wesely Publishing Company.
3	Keith F. Purcell and John C. Kotz, Inorganic Chemistry, 3rd Edition.
4	S. J. Lippard and J. M. Berg, 1994, Principles of Bioinorganic Chemistry, University Science Books.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/101/104101121
2	https://nptel.ac.in/courses/104/101/104101116
3	https://nptel.ac.in/courses/104/105/104105031
4	https://nptel.ac.in/courses/104/105/104105120

Course Designed By: Dr. K.Sundaravel

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	S	S	S
CO3	S	M	S	S	S	S
CO3	M	S	S	S	S	S

CO4	**S**	**M**	**S**	**S**	**S**	**S**

*S-Strong; M-Medium; L-Low

Course code	**CHMA23C**	**PHYSICAL CHEMISTRY - II**	**L**	**T**	**P**	**C**
Core		**PHYSICAL CHEMISTRY - II (QUANTUM CHEMISTRY AND GROUP THEORY)**	**4**	**1**	**0**	**4**
Pre-requisite		**Understanding the physical and mathematical aspects of quantum mechanics**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to:

1. To present the basic principles of quantum chemistry and group theory.
2. To learn the theories and basics of quantum mechanical treatment and group theoretical approach.
3. To motivate the student to visualize the atomic and molecular patterns.

Expected Course Outcomes

On the successful completion of the course, students will be able to:

1	Understand the concepts of classical and quantum mechanicsto picture out the failure of classical mechanics. To comprehend the approximate methods in quantum mechanics.	**K4**
2	Recollect the dual character of electrons and apply the Schrödinger wave equation to particles in a system.	**K2**
3	Apply group theory and categorize the molecules based on the structure and bonding interactions.	**K3**
4	Analyze the solution in terms of energy and wave function for H, H-like atoms, andmultielectron systems and review the group's theoretical approach toward Spectroscopy.	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	**QUANTUM CHEMISTRY- I**	**12 hours**

Failure of classical mechanics and the success of quantum theory in explaining black body radiation - photoelectric effect and the H-atom spectrum - DeBroglie's matter waves - Heisenberg's uncertainty principle - Schrodinger equation - Born's interpretation of the wave function - requirements of the acceptable wave function.

Algebra of operators - sums and products of operators - commutator - linear operators - eigen functions and eigenvalues - correspondence between physical quantities in classical mechanics and operators in quantum mechanics - Hamiltonian operator - quantisation of angular momentum and its spatial orientation - average (expectation) values - postulates of quantum mechanics.

Unit 2	**QUANTUM CHEMISTRY-II**	**12 hours**

Particle in a one-dimensional box - quantization of energy - normalisation of the wave function - orthogonality of the particle in a one-dimensional box wave functions - average position and average momentum of a particle in a one-dimensional box - illustration of the uncertainty principle and correspondence principle with reference to the particle in a one-dimensional box - particle in a three-dimensional box - separation of variables – degeneracy.

Schrodinger equation for the simple harmonic oscillator of a diatomic molecule - illustration of the uncertainty principle and correspondence principle with reference to harmonic oscillator. Schrodinger equation for a rigid rotor of a diatomic molecule. Schrodinger equation for the H-atom (or H-like species) - separation of variables - energy levels - radial factors of the H-atom wave functions.

Unit3	**APPLICATIONS OF QUANTUM CHEMISTRY**	**12hours**

Need for approximation methods - the perturbation theory (first order only) application of the perturbation method to He-atom - the variation method - applications of variation method to He-atom.

Electron spin and the Pauli principle – symmetric and antisymmetric nature of the wave functions - Slater determinants - approximate wave function of many electron atoms – Born-Oppenheimer approximation - Elementary concepts of MO and VB theories - Hybridization – Huckel theory of linear conjugated systems – Cyclic systems – Wood-ward Hoffman rules.

Unit 4	**GROUP THEORY**	**12 hours**

Symmetry elements and symmetry operations - identity - centre of symmetry - axis of symmetry - plane of symmetry and improper rotation axis of symmetry. Groups and their properties - molecular point groups and classification - matrices-matrix representation of symmetry operations

Classes - representations - reducible and irreducible representations - properties of irreducible representations - Statement and proof of Great Orthogonality theorem and its consequences -

Construction of character table for C_{2v} and C_{3v} point groups.

Unit 5	APPLICATIONS OF GROUP THEORY	12 hours

Standard reduction formula relating reducible and irreducible representations - Symmetries of normal modes of vibration in non-linear molecules (H_2O, NH_3, BF_3) - Selection rules for vibrational spectra – IR and Raman active fundamentals – Mutual exclusion rule - Symmetries of M.O and symmetry selection rule for electronic transition in ethylene and formaldehyde - Hybridization schemes for atoms in ethylene and butadiene.

Unit 6	Self-study topics in Quantum Chemistry and Group Theory (Not for Examination)	

Preliminary mathematics; Fundamental concepts and problems in trigonometric - Exponential functions - Matrices Vector Algebra - Differential equations – Integrations - Legendre differential equations - Legendre and associated Legendre Polynomials - Hermite and Associated Laguerre polynomials - Orthogonal functions and Sturm-Liouville problems.

Polyatomic Molecules - localized and delocalized molecular orbitals - H_2O molecule - hybridization and non-equivalent hybrids - construction of sp, sp^2, sp^3, dsp^2, and d^2sp^3 hybrids and non-equivalent sp, sp^2, and sp^3 hybrids.

Symmetry selection rules for vibrational - Electronic and Raman Spectra – determination of representation of vibrational modes in non-linear molecules such as CH_4, $XeOF_4$, and SF_6 – symmetry of Hybrid orbitals in non-linear molecule (CH_4 and PCl_5).

	Total Lecture hours	60 hours

Text Book(s)

1. F. A. Cotton – Chemical applications of group theory, Wiley India Pvt Ltd 3rd Ed., 2008

2. W. J. Moore - Physical Chemistry, 5th Ed., 1998.

3. A. K. Chandra - Introductory Quantum Chemistry, 4th Ed., 2017.

Reference Books

1	I. N. Levine - Quantum Chemistry, 7th Ed., Pearson India, 2016.
2	R. K. Prasad - Quantum Chemistry, 4th revised Ed., New Age International Pvt. Ltd, 2014.
3	G.W. Castellan - Physical Chemistry, 1983.

4	P. Atkins - Physical Chemistry, Oxford University Press, 8th Ed., 2006.
5	Swarnalakshmi S. - A Simple Approach to Group Theory in Chemistry, Universities Press, 2009.
6	Raman, K.V. - Group theory and its applications to chemistry, Tata Mac Graw Hill, 2004.
7	Advanced Engineering Mathematics by ERWIN KREYSZIG.
8	Allied Mathematics by Dr. P.R. Vittal
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/101/104101126/
2	https://nptel.ac.in/courses/104/101/104101094/
3	https://nptel.ac.in/courses/104/108/104108057/
Course Designed By: Dr.T.Selvaraju	

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	M	M	M	S	S
CO2	M	M	M	M	S	S
CO3	M	M	S	S	M	M
CO4	S	M	M	M	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA2EA	Elective -IV	L	T	P	C
Elective		Inorganic Spectroscopy	4	1	0	4
Pre-requisite		Knowledge in structural behavior of chemical compounds	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are

1. To understand the role of IR, Raman, ORD & CD spectroscopic techniques in inorganic chemistry.
2. To acquire intense knowledge about the electron paramagnetic resonance spectroscopy and its applications in structural elucidation of organic radicals and inorganic compounds.
3. To gain in-depth knowledge of inorganic NMR, NQR spectroscopy and to analyze the structure of various compounds.
4. To elucidate the structure of iron and tin compounds in different oxidation states by using Mossbauer Spectroscopy.
5. To get deeper insight on the use of photoelectron spectroscopy and X-ray absorption spectroscopy as analytical techniques for structural investigation.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1.	To gain knowledge about the basic principles of various inorganic spectroscopic techniques.	**K1**
2.	To understand the importance of different spectral techniques.	**K2**
3.	To apply the gained knowledge to evaluate the structure of various compounds using different spectroscopic techniques.	**K3**
4.	To analyze the electronic properties and bonding mechanism in various inorganic compounds.	**K4**
5.	To solve the problems related to inorganic spectroscopy.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	IR, Raman, ORD and CD Spectroscopy	12 hours
Infrared and (Resonance) Raman and spectra of metal complexes. - Molecular vibrations of di and triatomic molecules - Metal-ligand vibration - Band assignment - Resonance enhancement - Mechanisms - Excitation profiles, Multimode effect - Application to 2Fe-2S, 4Fe-4S and 3Fe-4S proteins and elucidation of binding mode of dioxygen in enzymes. Circular Dichroism spectroscopy - Basic principle - Origin of optical activity - chirality and nomenclature of chiral complexes - Cotton effect- optical isomerism in octahedral complexes - absolute configuration of complexes - stereoselectivity and conformation of chelate rings - Optical Rotatory Dispersion and linear dichroism - examples - application of CD in conformation analysis of biomolecule(s) (DNA).		

Unit 2	Electron Paramagnetic ResonanceSpectroscopy	12 hours
ESR introduction - Zeeman equation, g-value, nuclear hyperfine splitting - interpretations of the spectrum, simple carbon centered free radicals. Anisotropy-g-value and hyperfine splitting constant - McConnel's equation - Krammer's theorem – spin-orbit coupling – dipolar contribution – dipole-dipole interaction - ESR of transition metal complexes (copper, manganese and vanadyl ions) – isotropic, axial and rhombic spectra of copper(II) systems – Application of EPR: structural elucidation of coordination complexes: determination of electron delocalization, bonding mechanism of dioxygen adducts of dinuclear cobalt complexes, EPR of blue copper proteins.		

Unit3	Inorganic NMR and NQR Spectroscopy	12 hours
^{31}P ,^{19}F NMR spectrum of HPF_2, PF_5, PCl_2F_3, P_4S_3, TiF_4, BrF_5, SF_4, SF_6, XeF_4O, SiF_6^{2-}, $B_3H_8^-$, NF_3, $P_3N_3Cl_4F_2$, ClF_5, ClF_3,phosphorous and hypophosphorous acid systems, $HP(O)F_2$, $HOP(O)FH$ - use of lanthanide compounds as shift reagents. NMR applications to metalloproteins - paramagnetic complexes. NQR - Principles – Introduction - Nuclear Quadrupole Energy Levels - Energy Levels and transition frequencies – Effect of a magnetic field - The Zeeman effect - Factors affecting the Field Gradient- Applications of NQR: Interpretation of eQq data- Solid state effect-Structural information.		

Unit 4	Mossbauer Spectroscopy	12hours
Introduction - Principle of the Mössbauer Effect and Basic Concepts of Mössbauer Spectroscopy - Doppler shift - Experimental Resonance Conditions - Sharpness of resonance - Recoil Effect - Cross-section for Resonant Absorption - Comparison Between Electronic and Nuclear Transitions - Mössbauer-Experiment (Mössbauer spectrometer black diagram only) - Hyperfine Interactions and Mössbauer parameters: Isomer Shift, Electric Quadrupole Splitting, Magnetic Dipole		

Splitting, Applications: Mossbauer spectra of high- and low-spin iron compounds and tin halides systems: Prussian blue-Turn bulls blue, iron-carbonyl compounds, Sodium nitroprusside, FeX_2, SnX_4, SnX_6^{2-}, SnX_5Y^{2-} (X and Y = F^-, Cl^-, Br^-, I^-) Tin halides - Spin Crossover, Molecular magnetism - Bioinorganic Compounds.

Unit 5	**Photoelectron Spectroscopy and X-ray Absorption Spectroscopy**	**12 hours**

Photoelectron spectroscopy (UV and X-ray) – Physical principle – Experimental details - Koopman's theorem - chemical shift and correlation with electronic charges – Applications of PES.

X-ray absorption spectroscopy (XAS) and Extended X-ray absorption fine structure (EXAFS) – Applications of X-ray absorption spectroscopy. X-ray Absorption Edges - X-ray Fluorescence - Measurement of X-ray Absorption Spectra -Theoretical Description of EXAFS Spectra - Single scattering, Multiple scattering – Data reduction and analysis - Applications: structure determination, Resolution of crystallographic disorder, Oxidation state, prediction of molecular symmetry, determinations of atoms present in the first coordination sphere (Edge and EXAFS analysis) – Structure of Metal clusters.

Unit 6	**Mass Spectrometry of Inorganic compounds** **(Not for examination)**	

Experimental arrangements – Operation and Representation of Spectra- Molecular ion – Fragmentation – Ion reactions- Thermodynamic data – Fingerprint application and the interpretation of mass spectra – Effect of Isotopes on the appearance of a Mass spectrum – Molecular weight determinations - Appearance Potentials and Ionization Potentials.

	Total Lecture hours	**60 hours**

Text Book(s)

1**.** R. S. Drago - Physical methods in Inorganic Chemistry.

2. Donald L. Pavia, Gary M. Lampman and George S. Kriz, Jr - Introduction to Spectroscopy: A Guide for students of organic chemistry

Reference Books

1	Lawrence Que, Jr.- Physical Methods in Bioinorganic Chemistry.
2	A. K Das - Bioinorganic Chemistry.
3	E. A.V Ebsworth, D. W. H. Rankin and S. Cardock- Structural Methods in Inorganic

	Chemistry.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/106/104106048/
2	https://nptel.ac.in/courses/104/108/104108124/
Course Designed By: Dr. B. Murugesapandian	

Mapping with Programme outcomes

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**M**	**M**	**M**	**S**	**S**
CO2	**M**	**M**	**M**	**M**	**S**	**S**
CO3	**M**	**M**	**S**	**S**	**M**	**M**
CO4	**S**	**M**	**M**	**M**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**

*S-Strong; M-Medium; L-Low

Course code	CHMA2EB	Elective-V	L	T	P	C
Elective		**Energy, Dairy and Drug Chemistry**	**4**	**1**	**-**	**4**
Pre-requisite		**Background knowledge of Bio chemistry with an interest in drug discovery**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to:

1. To teach the students about the various factors responsible for the air pollution
2. To learn about the energy conservation mechanism
3. To study the types of drugs and their action on various diseases.
4. To learn the principle, properties and production of diary related products.
5. To acquire the knowledge on different types of soil, effective utilization of fertilizers and insecticides.

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	Understood the Quality of air, pollutants and its lethal effects	**K1 & K2**
2	Acquired knowledge on sustainable energy	**K2**
3	Studied the usage of drugs for different diseases	**K3 & K4**
4	To understand the process of making different dairy products	**K6**
5	Impart their knowledge on soil fertility, residue and proper usage of fertilizers	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	**POLLUTION-ENVIRONMENTAL ISSUE**	**12 hours**

The air we breathe-composition of air-burning of hydrocarbons- air quality-ozone-oxygen/ozone screen-biological effect of UV radiation-ozone formation and distribution in the atmosphere-paths of ozone destruction-chlorofluorocarbons and their interactions with ozone.

Chemistry of global warming-greenhouse effect-earth's energy balance-vibrating molecules and

the greenhouse effect-molecular response to radiation-methane and other greenhouse gases-climate modeling-Neutralizing the threat of acid rain.		
Unit 2	**NEW ENERGY SOURCES FOR THE NEW CENTURY**	**12 hours**
Renewable energy sources-Introduction to Solar energy-Waste Bio-Mass energy-Sea wave energy-Tidal energy-Ocean thermal conversion energy-Geothermal energy-Wind energy-Nuclear fusion energy. Solar Energy-Fuel from sunlight-splitting of water-hydrogen from sunlight-hydrogen economy-fuel cells-batteries-photovoltaics-stealing the sun. Nuclear energy- nuclear fission and fusion-production of electricity by nuclear reactor-radioactivity and the hazards of radioactivity-living with nuclear power.		
Unit3	**DRUGCHEMISTRY**	**12hours**
Antibacterial Drugs-(i) Sulpha drugs, (ii) Antibiotics-Sulphanilides-Properties of Sulphanilamides, Mechanism of Action of Sulpha drugs, Sulphadiazine, Cibazole, Sulphafurazole, Prontosil; Antibiotics; Classification of Antibiotics; Chloramphenical; Penicillin; Streptomycin; Tetracycline; Macrolides. **Anticonvulsant Agents-**Barbiturates-Synthetic uses; Mydantoin; Oxazolinediones; Acetyl Urea derivatives; Succinimides; Miscellaneous. **Acquired Immuno Deficiency Syndrome (AIDS)-**Introduction; Prevention; Treatment-Heterocyclic compounds as (eg., Quinoline, Carbazole, Coumarin and Naphthyridines)-HIV Integrase Inhibitors – Anti-HIV natural products - Synthesis. **Awareness through chikungunya -**Chikungunya, Causes; Virus; mosquito; Emergent in drug discovery- Comparative studies with malaria.		
Unit4	**DAIRY CHEMISTRY**	**12 hours**
Milk and Milk products-Composition of Milk; Flavour and aroma of Milk; Physical properties of Milk; Effect of heat on Milk; pasteurization; Homogenisation; milk products; Cream; butter; ice cream; milk powder.		
Unit5	**AGRICULTURAL CHEMISTRY**	**12 hours**
Soil Chemistry-Introduction; Soil classification and survey; Properties of Soil; Soil Texture; Soil Water; Soil Temperature; Soil Colloids; Soil Minerals; Soil pH acidity and alkalinity; Buffering		

Soil; Soil Fertility; Soil formation.

Insecticides, Fungicides and Herbicides- Introduction; Methods of Pest Controls; Methods of using Pest Controls; insecticides; the arsenic compounds; Fluorine compounds; Boron compounds; Mercury compounds; Copper compounds; Sulphur compounds; Modern Insecticides; Some Important Herbicides; Rodenticides; Benefits of Pesticides; Adverse Environmental effects of pesticides.

Fertilizers- Classification of Fertilizers; Important example for Fertilizers; Nitrogeneous fertilizers, Phosphate fertilizers, Potash fertilizers; Effects of fertilizers.

Manures, compost and saw dust- Farm yard Manure; Compost; Reinforcing Manure; Green Manure Crops; Saw dust; Night soil, sewage and sludge; Bio gas production and Manure.

Unit 6	**LEATHER CHEMISTRY (Not for examination)**	

Introduction; Structure of Hides & skins – Outline of Chief processes used in leather manufacture IA processes before tannage: Flaying; Curing, soaking, Unhairing; Liming; Fleshing; Deliming; Bating; Pickling- IIB Tanning process methods of Tanning: Vegetable Tanning; Chrome Tanning; Aldehyde Tannage: IIIC Finishing Process After Tannage- Tannery effluent- Primary Treatment – Secondary Treatment – Tertiary Treatment.

	Total Lecture hours	**60 hours**

Text Book(s)

1. Energy resources and the environment, V. K. Prabhakar, **2001.**

2. Fundamental Concepts of Applied Chemistry, Jayashree Ghosh, S.Chand, **2005.**

Reference Books

1	Chemistry in Context: Applying Chemistry to Society, Conard L. Stanitski. Luey Pyrde Eubenks. Catherine H. Middle Camp and Wilmer J. Stratton, third edition, **2000**, Mc Graw Hill.
2	Chemistry of the environment, Bailey, Clark, Ferris, Isrause, Strong, second edition, **2001** Elsevier publications.
3	I. P. Singh, S. B. Bharate and K.K.Bhutani, Current Science, Vol. 89, NO. 2, 25, July-**2005.**

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/109/101/109101171/
2	https://nptel.ac.in/courses/126/105/126105012/

Course Designed By: **Dr.T. Suresh**

Mapping with Programme outcomes

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**H**	**S**	**S**	**M**	**S**
CO2	**S**	**S**	**S**	**S**	**H**	**S**
CO3	**S**	**S**	**S**	**H**	**H**	**S**
CO4	**S**	**S**	**S**	**H**	**M**	**S**
CO5	**S**	**S**	**S**	**H**	**M**	**S**

S-Strong; H-High; M-Medium; L-Low

Course code	CHMA2EC	Elective-VI	L	T	P	C
Elective		ARTIFICIAL INTELLIGENCE	4	1	-	4
Pre-requisite		Design intelligent agents to solve real world problems	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. to introduce Artificial Intelligence and machine learning
2. to facilitate students to learn and apply AI tools for solving research issues
3. to understand the basics of robotic process automation
4. to develop automated solutions for research problems .

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Gained the knowledge on Artificial Intelligence and machine learnings	**K1 & K2**
2	Student will apply AI tools for solving research issues	**K2 & K3**
3	Student will understand the basics of robotic process automation	**K4**
4	Student can acquired the knowledge on automated solutions for research problems	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	Artificial Intelligence (AI)	12 hours

Introduction to AI – Fundamentals – Need for AI – Foundations of AI – AI environment – Application domains of AI – AI tools – Challenges and Future of AI

Unit2	Machine learning (ML) and Deep learning (DL) & Artificial Intelligence in Biology research	12 hours

Fundamentals of ML and DL – ML algorithms to find associations across biological data, cellular image classification and identification of genetic variations.

AI in drug design – AI in Phylogeny – AI in next generation sequencing – AI in protein structure

prediction – AI in protein folding analysis.		
Unit3	**Python programming**	**12 hours**
Introduction to Python language – Python, Machine learning and AI - Data types, variables and operators – Conditions and loops – Structure of a Python program – Packages and function – Writing simple python codes.		
Unit 4	**Robotic Process Automation (RPA)**	**12 hours**
Fundamentals of RPA – Programming basics from RPA perspective – Applying RPA – RPA development methodology – Architecture of RPA – RPA and emerging ecosystem.		
Unit5	**UiPath Studio**	**12 hours**
Introduction - Automation debugging – Automation library – Activities Packages – Basic automation tasks - Text and image automation – Data tables in RPA – Extracting data from data tables and pdf – Building simple Automation projects.		
	Total Lecture hours	**60 hours**

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/112/103/112103280/
2	https://nptel.ac.in/courses/106/106/106106145/
Course Designed By:	

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M	M	S	S	S	S
CO3	S	S	S	S	S	S
CO3	S	M	S	S	S	S
CO4	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA23P	PRACTICAL - II	L	T	P	C
Practical		INORGANIC CHEMISTRY PRACTICAL	0	0	6	4
Pre-requisite		Basic properties of Inorganic salts	Syllabus Version		2025-2026	

Course Objectives

1. To equip the students with analytical skills by analyzing the given inorganic salt mixture containing two common cations and two rare cations.
2. To perform systematic qualitative analysis with the strong theoretical back ground.
3. To impart knowledge on the quantitative analysis of different metal ions.
4. To enable the students to prepare simple complexes by using published reactions.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Able to identify the nature of any unknown metal ions	**K1, K2, K3, K4**
2	To identify the presence of microlevel compounds occurring in crude form in the nature	**K1, K2, K3, K4**
3	To determine the water quality in terms of metal content	**K4, K5**
4	Able to design and prepare the starting material leading to the synthesis of therapeutic compounds	**K3, K4, K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	Qualitative analysis	14 hours

Qualitative analysis employing semi-micro methods and spot tests of mixtures of common cations and cations of the following less familiar elements.

Tungsten, selenium, tellurium, molybdenum, cerium, zirconium, vanadium, and lithium.

(minimum 5)

Unit2	**Colorimetry**	**15 hours**
Colorimetric estimations of copper, nickel, iron and chromium using photoelectric colorimeter.		
Unit3	**Titrimetry**	**16 hours**
Complexometric titrations involving estimations of single cations: calcium, magnesium, nickel, and zinc; binary cation mixtures: Bi^{3+} - Zn^{2+}, Cu^{2+} - Zn^{2+} ions and hardness of water.		
Unit4	**Preparation of inorganic complexes**	**15 hours**

About six preparations involving different techniques selected from the following.

(i) Nickel ammonium sulfate

(ii) Potassium tris(oxalato)chromate(III)

(iii) Chloropentamminechromium(III) nitrate

(iv) Aquapentamminechromium(III) chloride

(v) Potassium tris(oxalato)ferrate(III)

(vi) Hexamminecobalt(III) chloride

(vii) Tris(1,2-diaminoethane)nickel(II) sulfate

(viii) Nickel(salen) complex

(ix) Tris(thiourea)copper(I) chloride

(x) Trans-bis(glycinato)copper(II)

(xi) Bis(acetylacetonato)copper(II)

(xii) Tetrammine copper(II) sulfate

(xiii) Hexathiourealead(II) nitrate

	Total hours	**60 hours**

Text Book(s)

1**.** V.V.Ramanujam, Inorganic Semimicro qualitative analysis, 3rd edition, National Publishing

company, 1974 2. R. Mukhopadhyay & P. Chatterjee, Advanced Practical Chemistry, Book & Allied (p) ltd 2007.	
Reference Books	
1	V.V.Ramanujam, Inorganic Semimicro qualitative analysis, 3rd edition, National Publishing company, 1974
2	Vogel's qualitative Inorganic analysis, 6th edition Longman.
3	J.Men dham, R.C. Denney, M. J.K. Thomas Darid & J.Bares, Vogels quantitative chemical analysis, 6th edition prentice hall 2000.
Course Designed By: Dr. K. Sundaravel	

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	H	S	S	S	H
CO2	S	S	S	S	S	S
CO3	S	S	S	H	S	S
CO4	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	GS73	SUPPORTIVE -II	L	T	P	C
Supportive		CHEMISTRY IN DAY TO DAY LIFE	2	0	0	4
Pre-requisite		Understanding the significance of Industrial products	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are

1. To acquire the fundamental concepts related to the chemistry in daily life
2. To understand the importance of different types of commercial products for the environment
3. To apply the basic concepts of chemistry in the manufacture of commercial products for the society
4. To find the efficiency and the utility of the byproducts derived from the basic and applied concepts of chemistry
5. To have knowledge about the basic concepts of various micronutrients, fertilizer, dyes, disinfectants and detergents.
6. To introduce the properties, structural elucidation, applications and the demerits of the products of the applied chemistry.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	To introduce the concepts, definition and importance of the chemistry in the form of various products.	**K1**
2	To understand the occurrence, source, types, uses and demerits of the industrial products	**K2**
3	To gain the knowledge of the implementation of fundamental chemistry concepts in the manufacture of commercial products for the society	**K4**
4	To analyze the structural relationship of the commercial materials with the effect of applications and the biological implications of micronutrients	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Essential Micronutrients	6 hours

Carbohydrates - Proteins - Lipids - Nucleic acids and Vitamins – Definition, Sources, Classification, Applications and Diseases due to deficiency.		
Unit 2	**Soil Nutrients and Food Additives**	**6 hours**
Fertilizers – Pesticides - Insecticides – Definition, Classification, Characteristics and Uses. Additives –Definition, Characteristics, Uses and Abuse of additives in foods and beverages		
Unit 3	**Dyes, Paints and Pigments**	**6 hours**
Dyes – Definition, Classification based on mode of application and structure, Applications. Paints – Definition, Ingredients, Characteristics, uses and drying process. Pigments -Varnishes - Definition, Characteristics, Types and Uses.		
Unit 4	**Soaps, Detergents and Disinfectants**	**6 hours**
Soaps and Detergents - Definition, Ingredients, Classification, Characteristics and Uses. Disinfectants – Definition, Characteristics and Uses. Perfumes - Definition, Characteristics, Raw materials and perfumes used in soaps - Cosmetics.		
		1 hour
Power Point Presentation: Micronutrients **Seminar:** Fertilizers, Pesticides and Insecticides **Assignment:** Dyes and Paints		
	Total Lecture hours	**25 hours**

Text Book

1. Industrial Chemistry by B.K.Sharma,Goel publishing House, Meerut.

Reference Books

1	K.Bagavathi Sundari (2006), Applied Chemistry, MJP Publishers.
2	Des W.Connell (2016). Basic Concepts of Environmental Chemistry, Second edition, Taylor & Francis Group.
3	Ley E.Manahan (2009), Fundamentals of Environmental Chemistry, Third Edition, CRC Press, Taylor & FrancisGroup.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/105/105/105105200/
2	https://nptel.ac.in/courses/116/104/116104044/
Prepared by : Dr. I. Prabha	

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	H	S	S	S	H
CO2	S	S	S	S	S	S
CO3	S	S	S	H	S	S
CO4	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA33A	Organic Chemistry –III	L	T	P	C
Core		Modern Organic synthesis, Photochemistry, and Pericyclic reactions	4	1	-	4
Pre-requisite		Basic idea on the reaction mechanism, photochemistry, and the orbital symmetry of molecules	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are

1. To understand the basic concept of organic reaction and the mechanism involved in organic reactions, and the concept of retrosynthetic analysis involved in total organic synthesis
2. To know the basic principles of photochemistry of alkenes and ketones in aromatic systems
3. To acquire knowledge about pericyclic reaction and their stereochemistry involved in organic molecules.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	To remember the basic concept of organic reactions and retrosynthetic techniques used in organic synthesis. To keep in mind the basic principles involved in photochemistry and pericyclic reactions	**K2**
2	To understand the basic concept of retrosynthetic analysis, protection and deprotection of functional groups in organic compounds. Understand the concept involved in photochemistry and Pericyclic reactions.	**K4**
3	To apply the concept of retrosynthetic analysis to find an easy and simple synthetic route for the synthesis of targeted molecules, the basic knowledge of photochemistry and pericyclic reactions in organic molecules is required toget the exact stereochemistry of the reaction systems.	**K5**
4	To investigate organic chemistry problems using organic reactions, retrosynthesis, photochemistry, and pericyclic reactions in competitive examinations.	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Organic reactions	12 hours

Evans aldol reaction, Mukaiyamaaldol reaction, Barbier coupling reaction, Corey-Chaykovskyepoxidation, Corey-Fuchs alkyne synthesis, Dakin oxidation, Hantzschdihydropyridine synthesis, Henry reaction, HWE olefination, HWE olefination-Still modification, Kagan-Molander coupling, Keck asymmetric allylation, Knoevenagel condensation, Passerini multicomponent reaction, Perkin reaction, Pictet-Spengler tetrahydroisoquinoline Synthesis, Prins reaction, Roush asymmetric allylation, Sakurai allylation, Seyferth-Gilbert homologation, Stetter reaction, Strecker reaction, Takai-Utimotoolefination, Tebbeolefination, Wittig reaction-Schlosser modification. Hajos-Parrish reaction, Nazarov cyclization, Pauson-Khand reaction, Bergman cycloaromatization, Danheiserbenzannulation, Dötzbenzannulation. Doering-LaFlammeallene synthesis, Liebenhaloform reaction

Unit 2	**Retrosynthetic analysis, protection, and deprotection**	**12 hours**

An introduction to retrosynthesis - synthon – synthetic equivalent – target molecule, functional group interconversion. Linear and convergent synthesis, umpolung of reactivity. Retro synthetic analysis and Synthesis of simple organic molecules such as 1,2, 1,3, 1,4, and 1,5-dicarbonyl compounds (both acyclic and cyclic). Formation of 3, 4, 5, and 6-membered cyclic compounds. retro Diels-Alder reactions - Wieland Miescher ketone synthesis - Retrosynthesis of 3, 4, 5, 6-membered carbo and heterocycles. Protection and deprotection of functional groups - R-OH, RCHO, R-CO-R, R-NH_2, and R-COOH. Use of PTC (phase-transfer catalyst) and Crown ethers in organic synthesis.

Unit 3	**Photochemical Excitation and Ketone Photochemistry**	**12 hours**

Light absorption - Experimental techniques - Electronic transitions - Franck-Condon principle - Jablonski diagram - Intersystem crossing - Energy transfer - Molecular orbital view of excitation - The geometry of excited states - Reactivity of electronically excited ketones - α- cleavage - γ-hydrogen transfer Norrish Type I and Type II reactions – Photo reduction - oxetane formation – Reactivity of π-π* excited ketones – Photochemistry of α, β- unsaturated ketones - photo dienone-phenol rearrangement.

Unit4	**Photochemistry of Alkenes and Aromatic Compounds**	**12hours**

Olefin photochemistry - conjugated olefins - Isomerisation and rearrangements - cis-trans isomerisation - valence isomerisation - rearrangement of 1,4 and 1,5 dienes - di-pi methane rearrangement - Cope and Claisen rearrangement - cycloaddition reactions - Photochemistry of Aromatic compounds - Arene photo isomerisation – Photo dimerization - Cycloaddition reaction – 1,2 cycloaddition – Photo oxygenation.

Unit 5	**Pericyclic Reactions and its Stereochemistry**	**12 hours**

Pericyclic Reactions: Concerted reactions – orbital symmetry and correlation diagram approach – FMO and PMO approach, Woodward -Hofmann rules – Electrocyclic reactions (1,3 -butadiene - cyclobutene and 1,3,5 -hexatriene - cyclohexadiene systems) – cycloadditions [2+2] and [4+2] systems (ethylene to cyclobutane, 1,3 - butadiene and ethylene to cyclohexene systems) – concerted Vs non-concerted cycloaddition – Reactivity of dienophile and diene - selection rules – cycloreversion (reterocycloaddition reactions) – 1,3 - dipolar cycloaddition - Sigmatropic reaction – Stereochemistry of Sigmatropic reactions.

Self-Study (NOT FOR EXAMINATION)

Unit 6	**Retrosynthetic analysis of Natural products**	

Retrosynthetic Analysis of Fumagillol, Ibogamine, Estrone, Longifolene, Porantherine, Gibberellic Acid and Retigeranic Acid.

	Total Lecture hours	**60hours**

Text Book(s):

1. P.S. Kalsi, Organic Synthesis through Disconnection Approach, 3rd Ed., Medtech Science Press, 2022.
2. Jie Jack Li, Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications, 7th Ed., Springer Cham, 2025.
3. J.D. Coyle, Photochemistry in Organic Synthesis, The Royal Society of Chemistry, 1986.
4. Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, 4th Ed., New Age International Publishers, 2019.

Reference Books

1	E.J. Corey and Xue-Min Cheng, The Logic of Chemical Synthesis, 1st Ed., Wiley-Interscience, 1995.
2	LászlóKürti and Barbara Czakó, Strategic Applications of Named Reactions in Organic Synthesis, 1st Ed., Academic Press, 2005.
3	Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro Jr., Name Reactions and Reagents in Organic Synthesis, 2nd Ed., Wiley-Interscience,2005.
4	O. Buchardt, Photochemistry of heterocyclic compounds, John Wiley & Sons Inc,1976.
5	N.J.Turro, V. Ramamurthy, and J.C. Scaiano, Modern Molecular Photochemistry for Organic Molecules, 1st Ed., Viva Books Private Ltd, 2016.
6	Charles H. Depuy, Orville S. Chapman, Molecular reactions and Photochemistry, Prentice-Hall, 1975.
7	Ian Fleming, Frontier Orbitals and Organic Chemical Reactions, 1st Ed., Wiley, 1991.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104105087
2	https://archive.nptel.ac.in/courses/104/103/104103023/
3	https://archive.nptel.ac.in/courses/104/105/104105038/
4	https://archive.nptel.ac.in/courses/104/106/104106077/
Course prepared by : Dr. A. Kannan	

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO3	M	S	S	S	S	S
CO3	S	S	M	S	S	M
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA33B	Inorganic Chemistry –III	L	T	P	C
Core		Solid State and Nuclear Chemistry	4	1	0	4
Pre-requisite		Fundamental concepts of the structure of the atom and isotopes	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are

1. To gain the basics in solid state chemistry.
2. To emphasize the significance of crystallographic properties and description of crystal structures.
3. To acquire awareness about the defects in crystal structure and its effect in electrical properties.
4. To understand the working principle and application particle accelerator and counters.
5. To get knowledge about the application of nuclear chemistry.

Expected Course Outcomes

On the successful completion of the course, student will be able

1.	To know through knowledge about the basics of solid state chemistry, X-ray crystal structure of the compounds, important feature of spinels, lattice energy, various defects in crystals and electrical properties of solids.	**K1**
2.	To understand the various types of close packing arrangements of different solid structures.	**K2**
3.	To understand the basics concepts of nuclear structure of atomic nucleus and able to apply the notions to solve the problems of atomic nuclei.	**K3**
4.	To get clear idea about the basics of nuclear chemistry and its application in various fields.	**K4**
5.	To create the various models of solid state structures	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Solid State Chemistry –I	12hours
The growth and form of crystals - the crystal systems and Bravais lattices - Miller indices and labelling of planes - symmetry properties - crystallographic point groups and derivation of space groups for triclinic and monoclinic cell systems- fundamentals of X-ray diffraction - powder and rotating crystal methods - systematic absences and determination of lattice types - analysis of X-ray data for cubic system - structure factor and Fourier synthesis - electron and neutron diffraction and structure determination.		
Unit2	**Solid State Chemistry –II**	**12 hours**
Types of solids - close packing of atoms and ions - bcc, fcc and hcp voids - radius ratio - derivation - its influence on structures - structures of rock salt - cesium chloride - wurtzite - zinc blende - rutile - fluorite - antifluorite - diamond and graphite - spinel - normal and inverse spinels and perovskite - lattice energy of ionic crystals - Madelung constant - Born-Haber cycle and its applications.		
Unit 3	**Solid State Chemistry –III**	**12 hours**
Metallic state - free electron and band theories - non - stoichiometry - point defects in solids - Schottky and Frenkel defects - linear defects - dislocations - effects due to dislocations - electrical properties of solids - insulators - intrinsic semiconductors - impurity semiconductors (n and p-type) and superconductors - elementary study of liquid crystals.		
Unit4	**Nuclear Chemistry – I**	**12hours**
Nucleus: nuclear structure and density - stability of nuclei - packing fraction - even - odd nature of nucleons - n/p ratio - nuclear potential - binding energy and exchange forces - shell model and liquid drop model.Decay of radionuclei: rate of decay - determination of half-life period - secular equilibrium and decay series.Modes of decay: alpha, beta, gamma and orbital electron capture - nuclear isomerism - internal conversions - Q value - nuclear cross section - threshold energy and excitation functions. Particle acceleration and counting techniques: linear accelerator - cyclotron and synchrotron - betatron - G. M. counter - proportional and scintillation counters.		
Unit 5	**Nuclear Chemistry – II**	**12 hours**
Different type of nuclear reactions with natural and accelerated particles - transmutation - stripping and pick-up - spallation - fragmentation, etc. - fission - characteristics of fission reaction - product distribution and theories of fission - fissile and fertile isotopes - U235, U238, Th232 and Pu239 - atom bomb - nuclear fusion - stellar energy - synthesis of new elements - principles underlying the usage of radioisotopes in analysis - agriculture - industry and medicine - mechanism of chemical reactions - uses of radioisotopes in analytical chemistry - isotopic dilution analysis - neutron activation analysis and dating methods.		

Unit6	Supramolecular Chemistry (Not for examination)	
Basic concept and principles: history - molecular recognition - hydrogen bonds: definition, structure and stability, strength, secondary electrostatic interactions in hydrogen bonding arrays- non-covalent interactions: ion pairing, ion-dipole interactions, dipole-dipole interactions, dipole-induced dipole and ion-induced dipole interactions, *vanderwaals* or dispersion interactions- hydrogen bonding, halogen bonding, cation- interactions, anion-pi interactions, π-π interactions, closed shell interactions, aromatic-aromatic interactions- benzene crystals, edge-to-face vs. π-π stacking interactions, N-H- pi interactions- sulfur-aromatic interactions- benzene-hexafluorobenzene π-stacking- Biological supramolecular systems: ionophores, porphyrin and other tetrapyrrolic macrocycles, coenzymes, neurotransmitters, DNA and biochemical self-assembly. supramolecular reactivity.		
	Total Lecture hours	**60 hours**

Text Book(s):

1. H. J. Arnikar - Essentials of Nuclear Chemistry
2. N. B. Hannay – Solid State Chemistry

Reference Books

1	N. B. Hannay, Solid State Chemistry, Prentice Hall, 1967
2	L. V. Azaroff, Introduction of Solids, McGraw-Hill Inc., 1960
3	A. R. West, Solid State Chemistry and its Applications, John Wiley & Sons Ltd., 2nd Edition, 2014.
4	R. J. Silbey, R. A. Alberty, M. G. Bawendi, Physical Chemistry, John Wiley & Sons, Inc. Fourth Edition, 2005.
5	A. K. Das, Fundamental Concepts of Inorganic Chemistry, CBS, 2nd Edition, 2019
6	P. Atkins, J. d. Paula, Physical Chemistry, W. H. Freeman and Company, Eighth Edition, 2006.
7	S. Glasstone, Sourcebook of Atomic Energy, Krieger Publishing Company, 3rd edition, 1979.
8	G. Friedlander, J. W. Kennedy, E. S. Macias, J. M. Miller, Nuclear and Radiochemistry, John Wiley and Sons, 3rd edition, 1981.

9	J. W. Steed, J. L. Atwood, Supramolecular Chemistry, John Wiley & Sons, Inc. 2nd Edition, 2009.
10	J. M. Lehn, Supramolecular Chemistry, VCH, Weinheim, 1995.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/108/104108098/
2	https://nptel.ac.in/courses/104/104/104104101/
3	https://nptel.ac.in/courses/115/103/115103101/
Course Designed By: Dr. B.Murugesapandian and Dr.K.Sundaravel	

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	M	S	S	S	M
CO2	M	S	S	M	S	S
CO3	M	M	S	M	M	M
CO4	S	M	S	S	S	M
CO5	M	S	L	M	L	S

*S-Strong; M-Medium; L-Low

Course code	CHMA33C	PHYSICAL CHEMISTRY – III	L	T	P	C
Core		CHEMICAL KINETICS AND SURFACE CHEMISTRY	4	1	0	4
Pre-requisite		Basic kinetics concepts of a chemical equation, bonding, reactions, and it's stoichiometry	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. To learn the rate and order of different reaction kinetics.
2. To give a thorough introduction to slow and fast reaction kinetics and macromolecules.
3. To provide knowledge in homogenous and heterogeneous catalysis.

Expected Course Outcomes

On the successful completion of the course, students will be able to:

1	Get detailed knowledge about the rate of any reaction and various parameters that affect the rate.	K1
2	Understand the theories of catalytic activity and polymerization techniques.	K3
3	Apply the catalytic principles in large-scale industries.	K4
4	Impart knowledge in solid and liquid phase kinetics	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	CHEMICAL KINETICS	12hours

Rate of chemical reactions – kinetics of first, second and third order reactions – complex methods of determining rate laws, order, and molecularity concepts.

Theories of reaction rates: Arrhenius theory, hard-sphere collision theory of gas phase reactions – Potential energy surfaces – Activated complex theory for ideal gas reactions (formation in terms of partition functions) – Relation between activated complex theory and hard-sphere collision theory – Thermodynamic formulation-activated complex theory (Enthalpies and entropies of activation) – Kinetic isotopic effect.

Unit 2	KINETICS OF REACTION IN SOLUTION	12 hours

Comparison between gas phase and solution reactions – Cage effect – The influence of the solvent on the reactions between ions and reaction between ions and neutral molecules – Influence of ionic strength on rates of reactions in solution – Significance of volume and entropy of activation – Secondary salt effect.

Kinetic treatment of complex reactions: Parallel reactions of the same order (first or second order) – Reversible reaction of the same order (first or second order) – First-order forward and second-order backward – Consecutive first-order reactions, steady state and rate-determining step (or equilibrium) approximation of complex reactions – Chain reactions and explosions.

Unit 3	FAST REACTIONS	12 hours

Study by stop-flow techniques, relaxation methods – Flash photolysis, magnetic resonance methods - Kinetic theory of gases and its Postulates – Maxwell distribution of Molecular velocities - Expressions for most probable velocity, average velocity, root mean square velocity – Collision diameter, Collision frequency, Mean free path. Transport properties of gases – Thermal conductivity, Viscosity, Diffusion - principle of equipartition of energy.

Unit 4	HOMOGENEOUS CATALYSTS	12hours

Specific and general acid-base catalysis – Bronsted catalysis law – Acidity functions. Enzyme catalysis (single substrate reactions only) – Michaelis-Menton kinetics – Influence of pH and temperature on enzyme catalysis.

Surface Phenomenon and Heterogeneous catalysts - Adsorption and free energy relation at interfaces – Gibbs adsorption isotherm – Physisorption and chemisorptions – Adsorption isotherms (Langmuir and BET) – Measurement of surface area – Kinetics of heterogeneous catalysis (Langmuir Hinshelwood mechanism and Eley-Rideal mechanism) – Semiconductor catalysis.

Unit5	MACROMOLECULES	12 hours

Addition and condensation polymers, number average and weight average molecular weights of macromolecules – Determination of molecular weights – Kinetics of polymerization, molecular and free radical mechanism – Polymerisation in solution – Stereochemistry.

Unit 6	Mathematical modeling and simulation in Chemical Kinetics and Biodegradable polymers and Bioplastics: (Not for Examination)	

Mathematical modeling and simulation in Chemical Kinetics: Ionic strength with CHEMSIMUL – Maintain constant concentration of solute – Equilibrium of gas phase with solution - Mass balance of G-values – Handling of an equilibrium – Zero-order reaction.

Biodegradable polymers and Bioplastics: The 21st century polymers: Biodegradable polymers classes - Natural biodegradable polymer - Synthetic and modified naturally biodegradable polymer - Bioplastics and biocomposites - processing and applications.

	Total Lecture hours	**60 hours**

Text Books:

1.K.J. Laidler, Chemical Kinetics, Pearson, 3rd Ed., 2003.

2. Gurdeep Raj, Chemical Kinetics, Krishna Prakashan Media Pvt. Ltd., 2016

3. P. Atkins - Physical Chemistry, Oxford University Press, 8th Ed., 2006.

Reference Books

1	W. J. Moore - Physical Chemistry, 5th Ed., 1998.
2	A.A.Frost and R.G. Pearson, Kinetics and Mechanism, 1961.
3	F.W. Billmeyer, Text book of Polymer science, Wiley- Interscience, 3rd Ed., 2007.
4	P. Kirkegaard, E, Bjergbakke and J.V. Olsen (2008) CHEMSIMUL: A chemical kinetics software package.
5	Hand Book of Biodegradable polymers Catia Bastioli, - Rapra Tech
6	Biopolymers, R.M. Johnson, L.Y. Mwaikambo and N. Tucker
7	Hand Book of Bioplastics & Biocomposites for Engineering Applications Srikanth Pillai

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/106/104106094/
2	https://nptel.ac.in/courses/103/106/103106116/

Course Designed By: Dr.M.Ilanchelian

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	S	S	M	M
CO2	S	S	S	M	L	S
CO3	M	S	S	M	M	S
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	**CHMA3EA**	**Elective-VII**	**L**	**T**	**P**	**C**
Elective		**BIOORGANICCHEMISTRY**	**4**	**1**	**0**	**4**
Pre-requisite		Understanding of important biological actions through organic and natural molecules	**Syllabus Version**		**2025-2026**	

Course Objectives:

The main objectives of this course are to: To teach the essential role of organic chemistry inbiology

1. To teach the vital role of vitamins in the biological systems
2. To teach the biosynthetic organic methodologies.
3. To teach the mode of vitamins and energy source in biologicalsystem
4. To teach novel reagents involved in bioorganicreactions
5. To teach the medicinalchemistry

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	Understood role and application of organic chemistry in biology and also vital role of vitamin in biological system.	**K2**
2	Clinical skills in biology by using organic knowledge	**K3**
3	Learnt the knowledge of organic reagents in biology	**K4**
4	Gained Knowledge about medicinal chemistry	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		
Unit 1	**Amino acids, Proteins, and Nucleic acids**	**12 hours**
Synthesis of amino acids and polypeptides - primary and secondary structure of a protein - the N-terminal and C-terminal residue analysis - oxytocin - enzymes and coenzymes - biosynthesis of protein - Nucleic acids - structure and synthesis of nucleosides - structure and synthesis of nucleotides -structure of RNA and DNA and their biological importance.		
Unit 2	**Vitamins**	**12 hours**
Structure and synthesis of vitamin B complex: vitamin B_1 (aneurin) - vitamin B_2 (riboflavin) - vitamin B_5 (pantothenic acid) - vitamin B_9 (folic acid) - vitamin H (biotin) - vitamin B_6 (pyridoxine) - vitamin B_{12} (cyanocobalamin) structure only - vitamin E (α-tocopherol) - vitamin K_1 (phylloquinone) and vitamin K_2.		
Unit 3	**Terpenoids**	**12 hours**
Isolation and classification - general methods to elucidate the structure of terpenoids - methods of structure elucidation and synthesis as applied to zingiberene - eudesmol - caryophyllene - abietic acid - santonin - biosynthesis of terpenes.		
Unit 4	**Bioenergetics**	**12 hours**
Concept of energy - thermodynamic principles - first law, second law, combining the two laws - relationship between standard free energy change and equilibrium constant. Standard free energy values of chemical reactions - Adenosine triphosphate (ATP) as universal currency of free energy in biological systems - ATP hydrolysis and equilibria of coupled reactions - inter conversion of adenine nucleotides.		
Unit 5	**Medicinal Chemistry**	**12 hours**
Design, development and mechanism of action of drugs: Antimicrobial, anticancer, antidiabetic, anti-inflammatory and anti-tubercular drugs. Cardiovascular drugs: cardiotonic, anti-hypertensive, anti-rhythmic and lipotropic drugs. Metals in Drug design: Historical development and advantages.		
Unit 6	**Antibiotics** (Not for Examination)	
Importance of antibiotics, History of discovery, Classifications. Structure, production and		

mechanism action of i) Penicillins ii) Streptomycin iii) Chloramphenicol (Chloromycetin) iv) Tetracycline derivatives – Oxytetracycline (terramycin) v) Cephalosoporins - Cephalosoporin-N, Cephalosoporin-C.		
	Total Lecture hours	**60 hours**

Text Book(s):

1. Organic Chemistry of Natural Products, Volume II, Gurdeep R.Chatwal

2. Medicinal Chemistry forthe21st Century. Ed. C. G. Wermuth, Blackwell, Oxford, 1992

Reference Books

1	Organic Synthesis, 2nd Edition by Michael B Smith, McGraw-Hill, New York. International Edition, 1994.
2	R.K. Mackie and D.M. Smith. 1998, Guide book to organic synthesis, ELBS Publication.
3	I.L. Finar, Organic Chemistry, 5thEdition,Vol.II, 1986, ELBSPublication.
4	L.Smith,RobertL.Hill.1.RobertLehman,RobertJ.IetRowitz,PhilpHandler andIbrahim white principles of Biochemistry General aspects, 7thEdition, McGraw Hill Int.
5	L. Stryer, Biochemistry, W.H.Freeman and Co., NewYork.
6	B.L. Smith, 1980, Organic synthesis, Chapman and Hall,NY.
7	Francis.A. Carey, Richard J. Sundbreg, 2001, AdvancedOrganic Chemistry, 4thEdition, Plenum Press,NewYork.
8	Drug Metabolism: Databases and High Throughput Testing During Drug Design and Development. Ed. P. W. Erhardt, Blackwell, Oxford, 1999.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/105/104105120/
2	https://nptel.ac.in/courses/104/103/104103121/
3	https://nptel.ac.in/courses/104/105/104105087/
4	https://nptel.ac.in/courses/104/106/104106106/
5	https://nptel.ac.in/courses/104/103/104103023/

Course Designed By: Dr. T. Suresh

Mapping with Programme outcomes

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	M	S	S	M
CO2	M	M	S	S	M	S
CO3	S	S	M	S	S	M
CO4	M	M	M	S	M	M

*S-Strong; M-Medium; L-Low

Course code	**CHMA3EB**	**Elective - VIII**	**L**	**T**	**P**	**C**
Elective		**INDUSTRIAL ORGANIC CHEMISTRY**	**4**	**1**	**-**	**4**
Pre-requisite		**Basic synthetic procedure involved in Chemical Industry**	**Syllabus Version**		**2025-2026**	

Course Objectives:

The main objectives of this course are to:

1. To teach the essential role of industrial process ofpetrochemicals
2. To teach methodologies involved in dyeing inindustries.
3. To teach preparation of soaps, oils andwaxes
4. To teach the chemistry of natural and syntheticpolymers.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Understood role of industrial process and application of petrochemicals	**K1**
2	Preparative skills in manufacturing soaps, dyes and waxes	**K2**
3	Learnt the knowledge of natural polymers as their behavior	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Industrial Organic Syntheses-Petrochemicals	12 hours
Introduction-Raw material and basic processes-chemical processes used in industrial organic synthesis-petrochemicals-methanol- ethanol-rectified spirit from beer-methylated spirit-proof spirit-preparation of absolute ethanol from rectified spirit-acetaldehyde-acetic acid-isopropanol-ethylene glycol-glycerine- acetone-phenol-ethylacetate.		
Unit 2	**Hydrocarbons from Petroleum**	**12 hours**
Introduction-raw materials-saturated hydrocarbons from natural gas-uses of saturated hydrocarbons-unsaturated hydrocarbons acetylene, ethylene, propylene and butylene. Aromatic hydrocarbons-benzene, toluene, xylenes-chemical processing of paraffin hydrocarbons,-acetylene and aromatic hydrocarbons.		
Unit 3	**Dyes**	**12 hours**
Introduction-sensation of colour-colour and constitution-nomenclature-basic operations in dyeing-classification of dyes according to the mode of application.-synthesis, reaction and applications of diphenyl methane dyes-triphenylmethane dyes-phthalein dyes- xanthene dyes-acridine dyes-Sulphur dyes-cyaninedyes.		
Unit 4	**Oils, Fats, Waxes and Soaps**	**12 hours**
Introduction-Distinction between oils and fats-properties and its classifications-animal fats and oils-difference between, animal, vegetable and mineral oils- isolation of essential oils and their uses-saponification value-ester value-acid value-iodine value-wijs method-Reichert meissl value-Henher value-elaiden test-hydrogenation of oils – Soap and its manufacture-general consideration in soap making –manufacture of toilet and transparent soaps-oil to be used for soap-cleansing action of soap.		
Unit 5	**Natural and Synthetic Polymer**	**12 hours**
Introduction-types of polymerization and their utility, mechanism involved in preparation-thermoplastic and thermosetting polymers- phenolic resins, polyurethanes, epoxy resins, alkyl resins. Natural and synthetic rubber-types and their utility-polymer properties and structure.		
Self-Study (NOT FOR EXAMINATION)		
Unit 6	**Pulp and Paper Technology**	

Introduction of pulp and paper technology: Manufacture of pulp, types of manufacturer of pulp-sulphate or kraft pulp- soda pulp-sulphite pulp-Rag pulp. Beating, refining, filling, sizing and colouring. Manufacture of paper-calendering-Uses- clean technologies in agro based industries. Ecological problems of Indian pulp and paper industry.		
	Total Lecture hours	**60 hours**
Text Book(s): 1. Industrial Chemistry (Including Chemical Engineering) B.K.Sharma (10^{th} Edition, 1999)		
Reference Books		
1	Industrial Chemistry (Including Chemical Engineering) B.K.Sharma(10^{th} Edition, 1999)	
2	Outlines of Chemical Technology – For the 21^{st} Century – M.Gopala Rao & Marshall Sittig (3^{rd} Edition, 1997)	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://nptel.ac.in/courses/113/105/113105077/	
2	https://nptel.ac.in/courses/116/104/116104044/	
Course Designed By: Dr. A.Kannan		

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	M	M	S	S	M
CO2	M	M	S	S	M	S
CO3	S	S	M	S	S	M

***S-Strong; M-Medium; L-Low**

Course code	CHMA3EC	Elective - IX	L	T	P	C
Elective		Data Analytics using R	4	1	0	4
Pre-requisite		Emphasis on statistical and analytical skills on computer language	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To introduce the concept of Data Analytics
2. To understand the features of R
3. To utilize the concept of data analytics and R

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Student get the knowledge about data analytics	**K2**
2	Student can apply the concept of data analytics	**K3**
3	Student can analyze new tools used in robotics	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1		12 hours

Introduction Data Analytics – Data Analysis Vs Data Analytics – Data Analytics – Types - Data Analytics – Framework – Data Analytics – Tool - R language - Understanding R features - Installing R and RStudio – Packages and Library – Importing and Exporting Files: CSV File – JSON File – txt File –Excel File – Xml File - Command Line Vs. Scripts. - Data Pre-Processing – Missing Value – Omitting Null Values – Data Transformation – Data Selection – Data Integration.

Unit 2		12 hours

Understanding R features - Installing R and RStudio – Packages and Library – Importing and Exporting Files: CSV File – JSON File – txt File –Excel File – Xml File – Command Line Vs. Scripts Data Manipulation: Slicing - Subscripts and Indices – Data Subset – Dplyr Package: Select Function - Filter Function - Mutate Function - Arrange Function.

Unit 3		**12 hours**
Data Summarization and Visualization - Mean – Median – Mode - Variability Measures - Variance – Range - IQR – Standard Deviation – Sum of Squares –Identifying Outliers using IQR. Data Visualization – Introduction – Datasets – Exploratory Data Analytics – Univariate Analysis – Histogram - Bivariate Analysis - Box Plot – Multivariate Analysis - Scatter Plot - MASS Package - Categorical Variable –Bar Chart – Mosaic Plot.		
Unit 4		**12 hours**
Reporting Tool – Analysing Gathering Information – Story Telling – R Markdown – R Markdown Framework - rmarkdown package – Knit for Embedded Code: knitr package - Convert File:HTML, PDF, MS Word - Markdown Formatted Text - ShinyApp – shiny package: Built Shiny app – Control Widgets – Customize Reactions – Reactive Expressions - Customize Appearance - Deploy Shiny app.		
Unit5		**12 hours**
Data Analytics Case Studies – Marketing – Logistic Management – Insurance – Behavioural Analytics – Data Analytics on Diamond Dataset.		
	Total Lecture hours	**60 hours**

Text Book(s):

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, ISBN-978-1-78216-328-2, 2013.

Reference Books

1	V. Bhuvaneswari, “Data Analytics with R Step by Step”, Scitech Publisher, ISBN – 978-81- 929131-2-4, Edition 2016.
2	Roger D.Peng, “R Programming for Data Science”, Lean Publishing, 2014.
3	Sholom Weiss, et.al, “The Text Mining Handbook: Advanced Approaches in Analysing Unstructured Data”, Springer, Paperback 2010.
4	Emmanuel Paradis, “R for Beginners”, 2005.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/106/107/106107220/
2	https://nptel.ac.in/courses/110/106/110106072/
Course Designed By:	

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	S
CO2	S	M	M	S	S	M
CO3	S	S	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code	**CHMA33P**	**PRACTICAL - III**	**L**	**T**	**P**	**C**
PRACTICAL		**PHYSICAL CHEMISTRY PRACTICAL**	**0**	**0**	**6**	**4**
Pre-requisite		Knowledge on phase transformations and titrimetry	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to:

1. To learn the practical knowledge about the chemical kinetics, conductivity and potentiometric titrations using lab scale experimental methods.
2. To motivate the students to understand the basic principles of chemical kinetics, potentiometric and conductometric titrations.
3. To learn proper maintenance of record observations and data interpretation.

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	To validate the theory of electrochemistry and the measurement of electrical conductance through the practical seasons.	**K2**
2	To understand the basic concepts of conductometric and potentiometric titrations and the quantitative analysis of unknown solutions using the corresponding	**K3**

	instruments.	
3	To know about the practical applications of chemical kinetics as well as to understand about the adsorption studies.	**K4**
4	To learn the measurement of cell potential, conductivity, pH etc., using various electrochemical instruments.	**K4**
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		
	Chemical kinetics (I and II order) - 5 Nos.	**15 hours**
Determination of rate constant of acid catalysed hydrolysis of an ester, Determination of Arrhenius parameters, kinetics of persulphate - iodine reaction, Study of primary salt effect, kinetics of iodination of acetone		
	Molecular weight determination - 1 No	**3 hours**
Rast method		
	Phase study	**3hours**
Simple eutectic system - 1 No.		
	Distribution coefficient - 2 Nos.	**6hours**
Partition coefficient of I_2, the study of equilibrium of the reaction between KI and iodine		
	Conductivity experiments - 6 Nos.	**15 hours**
Acid - base titration, mixture of acids vs NaOH, precipitation titrations, mixture of halides, Determination of dissociation constant, verification of Debye - Huckel Onsagar equation and Kohlraush law		
	Potentiometry - 5 Nos	**12hours**
(i) redox titrations		

(ii) acid - base titrations (iii) precipitation reactions		
	Validation of **Freundlich adsorption isotherm.**	**3 hours**
	Determination of unknown concentration of the given solution using **photoelectric colorimeter.**	**3 hours**
	Total Lecture hours	**60 hours**

Text Book(s):

1. P.S. Sindhu "Practical in Physical Chemistry", Macmillan, 2005

Reference Books

1	H.R. Crockford, J.W. Nowell, "Laboratory manual of Physical Chemistry", John Wiley and Sons, Inc.

Course Designed By: Dr. T. Selvaraju & Dr. S.N. Karthick

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	S
CO2	S	M	M	S	S	M
CO3	S	S	S	S	M	S
CO4	S	S	S	H	S	S

*S-Strong; M-Medium; L-Low

Course code	GS	Supportive III	L	T	P	C
Supportive		ENVIRONMENTAL CHEMISTRY	2	0	0	2
Pre-requisite		Basic idea about agriculture and dairy products	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. To acquire the basic concepts related to the chemistry for the effect of environment and the role of inorganic materials in biological applications
2. To understand the importance of different types, unique properties of the commercial products to the benefit of environment
3. To apply the basic concepts of chemistry in the manufacture of commercial products for the society
4. To find the efficiency and the utility of the byproducts derived from the basic concepts of chemistryTo have knowledge about the basic concepts of soil nutrients and effects, inorganic compounds, milk and oil.
5. To introduce the properties, structural elucidation, applications and the demerits of the products of the applied chemistry.

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	To introduce the concepts, definition and importance of the environmental chemistry in the form of various products.	**K2**
2	To understand the occurrence, source, types, uses and demerits of the industrial products and the inorganic compounds	**K4**
3	To gain the knowledge of the implementation of fundamental chemistry concepts in the manufacture of commercial products and its impact to the environment	**K3**
4	To analyze the structural relationship of the commercial materials with the effect of applications and the biological implications of inorganic compounds	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	**Impact of Soil**	**6 hours**
Soil-Introduction-Definition-Classification of Soil- Environmental properties of Soil-Soil minerals-Soil contamination- Ecological and health effects of Soil contamination.		
Unit 2	**Role of Medicinal Inorganic Compounds**	**6 hours**
Medicinal inorganic compounds-Alum, Phosphoric acid, Ferric ammonium citrate: Preparation, Properties and uses. Biological role of inorganic compounds-Sodium, Potassium, Calcium and Iodine: Sources, biological role and deficiency.		
Unit3	**Milk**	**6 hours**
Milk- Composition of milk-Properties of milk- Effect of heat on milk- Pasteurisation: Definition, process and its effects- Homogenisation- Milk products- Ice cream.		
Unit 4	**Introduction to Oil**	**7 hours**
Introduction- Oils- Definition, Classifications, Properties, and uses- Animal, Vegetable and Mineral oils- Fat-Definition- Functional properties- Types of Fat- Uses- Effect of fat on health.		
Power Point Presentation: Environmental properties and contamination of soil **Seminar**: Medicinal Inorganic Compounds **Assignment**: Milk and its importance		
	Total Lecture hours	**25 hours**
Text Book(s) 1. K.Bagavathi Sundari (2006), Applied Chemistry, MJP Publishers.		
Reference Books		
1	Des W.Connell (2016). Basic Concepts of Environmental Chemistry, Second edition, Taylor & Francis Group.	

2	Ley E.Manahan (2009), Fundamentals of Environmental Chemistry, Third Edition, CRC Press, Taylor & Francis Group
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/105/105/105105200/
2	https://nptel.ac.in/courses/104/106/104106106/
Course Designed By: Dr. I.Prabha	

Mapping with Programme outcomes

PO / CO	**PO1**	**PO2**	**PO3**	**PSO4**	**PO5**	**PO6**
CO1	M	H	S	S	S	H
CO2	S	S	S	S	S	S
CO3	M	S	S	H	S	S
CO4	S	S	S	H	S	

S-Strong; H-High; M-Medium; L-Low

Course code	CHMA43A	Organic Chemistry –IV	L	T	P	C
Core		Name reactions, Alkaloids, Steroids, Functional group transformations, and Reagents in Organic Synthesis	4	1	-	4
Pre-requisite		Basic knowledge of chemical compounds present in the natural products	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. To learn about naming reactions and their application in OrganicSynthesis
2. To learn about retro synthesis and biosynthesis of Alkaloids andSteroids
3. To learn about the functional group interconversion of organic molecules
4. To learn about the basic ideas and applications of organic reagents in organic synthesis

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	To understand naming reactions and their application in OrganicSynthesis	**K1**
2	To understand the Biosynthetic idea of Alkaloids and Steroids	**K2**
3	To gain the knowledge to convert one functional group into another in the organic synthesis.	**K3**
4	To review different types of reagents involved in chemical synthesis.	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Name reactions	12 hours

Baylis-Hillman, Duff, Simmons-Smith, Reformatsky, Ullmann, Wittig-Horner, Peterson, Julia olefination, Barton, Shapiro, Robinson annulation, Oppenauer oxidation, Eschweiler Clarke, Polonovski, Reissert, Mitsunobu, Leukart reaction, Bucherer, Willgerodt and Willgerodt-Kindler reaction.

Unit 2	Alkaloids	12 hours

Alkaloids – Properties, identification, function, classification, and extraction procedures. Structural elucidation of dictamnine - chinconine – quinine - morphine - reserpine - cocaine - lysergic acid and nicotine.		
Unit 3	**Steroids**	**12 hours**
Structural elucidation and spectrum of cholesterol (except Total Synthesis) - erogosterol - vitamin-D - equilenin - estrone - progesterone, stigmasterol, steroid hormones-androsterone, testosterone, oesterol, oestradiol, biosynthesis of steroids – Structure and synthesis of bile acids.		
Unit 4	**Functional group transformations**	**12 hours**
Carbonyl compounds (aldehyde and ketone) - Preparation from alcohols, alkenes, alkynes, arenes and carboxlic acid derivatives. Reactions: Nucleophilic additions-cyanide, bisulfate, ammonia,amines, oximes, hydrazines, semicarbazide, hydride, hydrogen, organometallic reagents, Cannizaro and Benzoin condensation reactions. Reaction of enones-1,2 and 1,4 additions. Oxidation of carbonyl compounds and Wittig reaction. Amines (both aliphatic and aromatic) - Methods of preparation of amines by reduction of nitro compounds, imine, amides and cyanides, Hofmann degradation of amides andammonolysisof halides. Reactions - basicity and acidityof different amines, salt formation, alkylation, acylation, Hofmann elimination and diazonium ion formation and its reactions. Reactions of aromatic amines.		
Unit 5	**Reagents in Organic Synthesis**	**12 hours**
Use of the following reagents in Organic synthesis and functional group transformation - diborane, dicyclohexylcarbodiimide (DCC), 1,3-Dithiane, lead tetraacetate (LTA), diisobutylaluminium hydride (DIBAL-H), 9-borabicyclo(3.3.1)nonane (9-BBN), Raney Nickel, polyphosphoric acid (PPA), diazomethane (CH_2N_2), Tri-n-butyl tin hydride, *n*-Butyl lithium, N-bromosuccinimide (NBS), 2,3-Dichloro-5,6-dicyano-1,4-benzoquinone (DDQ), diazabicyclo-undecane (DBU), trimethylsilyl iodide (TMSI), Gilman reagent, lithium diisopropyl amide (LDA).		
Unit6	**Anthocyanins (Not for Examination)**	
General nature of anthocyanin, structure of anthocyanidins, General methods of synthesizing the anthocyanidins. Flavones, isoflavones, biosynthesis of the flavonoids, depsides, and tannins.		
	Total Lecture hours	**60 hours**

Text Book(s)

1. R. T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Organic Chemistry, 7th Edition, PearsonEducation, 2010

2. Fieser& Fieser's – Reagents for OrganicSynthesis-Volume 1,John Wiley & Sons,1967.

Reference Books

1	I. L. Finar, Organic chemistry, vol. I and vol.II., Pearson Education 2014
2	L.G.Wade Jr., OganicChemistry, 8th Edition, Pearson Education, 1987.
3	L. F. Fieser und M. Fieser, Steroids. Reinhold Publishing Corporation, New York 1959.
4	P.J.Garrat, Aromaticity, Mc Graw Hill,1971.
5	Jerry March, Advanced Organic Chemistry - Reactions, Mechanism and Structure, Wiley-Interscience, 1992.
6	P. Y. Bruice, Organic Chemistry, 4th Edition, PearsonEducation, 2004
7	T. W. Graham Solomons and C. B. Fryhle, Organic Chemistry, 10th edition,Wiley

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/103/104103023/
2	https://nptel.ac.in/courses/104/103/104103111/

Course Designed By: Dr. T.Suresh

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	H	S	S	M	S
CO2	S	S	S	S	H	S
CO3	S	S	S	H	L	S
CO4	S	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code	CHMA43B	INORGANIC CHEMISTRY –IV	L	T	P	C
Core		ORGANOMETALLIC CHEMISTRY	4	1	-	4
Pre-requisite		Basics of metalloorganic chemistry	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to:

1. Learn about the development of organometallic chemistry and types of bonds in organometallic complexes
2. Learn about the important organometallic complexes and their applications in various organic transformations as homogeneous/ heterogeneous catalysts
3. Recognition of organometallic chemistry in Noble Prize for chemistry in 2001, 2005 and 2010

Expected Course Outcomes

On the successful completion of the course, student will be able to

1	Understand the historical development of Organometallic chemistry and uniqueness in various bonding behaviour of organometallic compounds.	**K2**
2	Gaining the knowledge on metal carbonyl compounds, various types of insertion reactions in carbonyl chemistry and their applications	**K2 & K4**
3	Organometallic alkyl, alkylidene and alkylidyne, alkene and alkyne chemistry and application of them in insertion, double carbonylation, olefin metathesis, hydrogenation, hydrosilation, oxidation and polymerisation reactions.	**K2 & K4**
4	Inferring the importance of metallocene chemistry and the applications of metallocenes in stereospecific polymerisation of 1-alkenes and fluxional behaviour of π-electron systems and importance of organometallic chemistry in catalysis and recognition of Noble prizes 2001, 2005 and 2010.	**K4**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	**Chemical bonding in organometallic compounds- Structure, bonding and reactivity of metal carbonyls**	**12 hours**

Definition of organometallic compound - effective atomic number rule –18-electron rule- classification of organometallic compounds - the metal carbon bond types - ionic bond – sigma covalent bond - electron deficient bond - delocalised bond - dative bond - metal carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding- binding mode of CO and IR spectra of metal carbonyls - metal carbonyls- metal carbonyl anions - metal carbonyl hydrides - metal carbonyl halides - metal carbonyl clusters – Wade's rule and isolobal relationship - metal nitrosyls - dinitrogen complexes - dioxygen complexes.

Unit 2	**Metal alkyl complexes, alkylidene and alkylidyne complexes: Synthesis, structure and reactivity**	**12hours**

Metal alkyl complexes - stability and structure - synthesis by alkylation of metal halides - by oxidative addition - by nucleophilic attack on coordinated ligands - metal alkyl and 18 electron rule - reactivity of metal alkyls - M-C bond cleavage reactions - insertion of CO to M-C bonds - double carbonylation - insertions of alkenes and alkynes - insertions of metals with C-Hbonds - alkylidene and alkylidyne complexes - synthesis of alkylidene complexes in low oxidation states and in high oxidation states - bonding in alkylidene complexes - synthesis and bonding in alkylidyne complexes - reactivity of alkylidene and alkylidyne complexes.

Unit 3	**Metal alkene and alkyne complexes :Synthesis, structure, bonding and reactivity**	**12 hours**

Alkene complexes - synthesis of alkene complexes by ligand substitution - by reduction and by metal atom synthesis - bonding of alkenes to transition metals - bonding in diene complexes - reactivity of alkene complexes - ligand substitution - reactions with nucleophiles - olefin hydrogenation - hydrosilation - Wacker process - C-H activation of alkenes - alkyne complexes - bonding in alkyne complexes - reactivity of alkynes - alkyne complexes in synthesis - cobalt catalysed alkyne cycloaddition.

Unit4	**Sandwich and half sandwich complexes : Structure and bonding**	**12 hours**

Cyclopentadienyl complexes - metallocenes - synthesis of metallocenes - bonding in metallocenes - reactions of metallocenes - Cp_2Fe/Cp_2Fe^+ couples in biosensors - bent sandwich complexes - bonding in bent sandwich complexes - metallocene halides and hydrides - metallocene and stereospecific polymerisation of 1-alkenes - cyclopentadiene as a non-spectator ligand - monocyclopentadienyl (half-sandwich) complexes - synthesis and structures of allyl complexes - arene complexes - synthesis - structure and reactivity of arene complexes - multidecker complexes.

Unit5	**Organometallic compounds in homogeneous catalysis**	**12 hours**

Organometallic compounds in homogeneous catalytic reactions - coordinative unsaturation – Reductive Elimination- Oxidative Addition- reaction - migration of atoms or groups from metal to ligand - insertion reaction - reactions of coordinated ligands - catalytic reactions of alkenes - isomerisation of alkenes - hydrogenation - hydroformylation and hydrosilation of alkenes - alkene polymerisation and oligomerisation.

Unit6	**Recognition of Organomatallic Chemistry in catalysis (Not for examination)**	

The Nobel Prize in Chemistry 2001- Asymmetric synthesis – Asymmetric oxidation- Asymmetric Hydrogenation, 2005- Olefins metathesis in organic synthesis (Yves Chauvin, Robert H. Grubbs and Richard R. Schrock methods) and 2010 – Palladium catalysed cross coupling reactions in organic synthesis (Heck, Negishi and Suzuki coupling reactions) – 2016-Molecular motors (Sauvage, Stoddart and Feringa - design and synthesis of molecular machines).

Power point Presentations, Group discussions, Seminar,Quiz, Assignment, Experience Discussion, Brain storming, Activity, Case study

Assignment: Types of bonding in organometallic chemistry and Nobel Prizes in chemistry.

Power point presentation: Bondings in metal carbonyls and metallocene complexes, nucleophilic reactions on coordinated ligands.

Seminar: Important catalytic reactions of various organometallic complexes.

	Total Lecture hours	**60 hours**

Text Book(s):

1. Basic organometallic chemistry, J. Haiduc and J. J. Zuckerman, Walter de Gruyter, Brelin, 1985.

2. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, Fourth Edition.

3. Organometallic and Bioinorganic Chemistry, Ajai Kumar, 4th Edition

Reference Books

1	Organometallics 1, Complexes with transition metal-carbon σ-bonds, Manfred Bochmann, Oxford science publications, Oxford, 1994.

2	Organometallics 2, Complexes with transition metal-carbon π-bonds, Manfred Bochmann, Oxford science publications, Oxford, 1994.
3	Inorganic Chemistry - Principles of structure and reactivity, J. E. Huheey Harper International Edition, Harper and Rone New York, 1978.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/101/104101123/
2	https://nptel.ac.in/courses/104/101/104101100/
Course Designed By: Dr. R. Prabhakaran	

Mapping with Programme outcomes

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	M	S	S	M
CO3	S	M	S	S	S	S
CO3	M	S	S	S	S	S
CO4	S	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMA43C	PHYSICAL CHEMISTRY – IV	L	T	P	C
Core		Classical and statistical thermodynamics	4	1	0	4
Pre-requisite		Thermodynamics principles and their properties.	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To study the concepts of classical thermodynamics and different theories of statistical thermodynamics.
2. To develop vast knowledge in the interpretation of various physical quantities involved in thermodynamics.
3. To explore the concepts of irreversible thermodynamics, and probability, distribution laws, partition functions.

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Understand the perceptions of classical and statistical thermodynamics.	**K1, K2**
2	Apply the third law of thermodynamics and irreversible thermodynamics.	**K2, K3**
2	Analyze quantum statistics and partition function.	**K3, K4**
3	Investigate the variation of fugacity, heat capacities, and various quantum statistics in the determination of probability.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit1	THERMODYNAMICS OPEN SYSTEM	12 hours

Chemical potential: concept - Gibbs-Duhem equation - variation with temperature and pressure. Fugacity: concept - determination of fugacity of a real gas from graphical method and Van der Waals equation – a variation of fugacity with temperature and pressure - a standard state and mixtures of non-ideal gases – determination of fugacity in gas mixtures (Lewis-Randall rule), chemical equilibrium involving non-ideal gas - the liquid mixtures. Activity: – standard state – rational and practical systems - dependence on temperature and pressure – determination of activity and activity coefficients of non-electrolytes.

Unit:2	THIRD LAW OF THERMODYNAMICS and IRREVERSIBLE THERMODYNAMICS	12 hours

Probability and third law – Nernst heat theorem and other forms stating third law – Thermodynamic quantities at absolute zero – Statistical meaning of third law and apparent exception.

Scope of irreversible thermodynamics - Thermodynamic criteria for non-equilibrium states - Phenomenological laws - Linear laws - Gibbs equation - Entropy production with specific examples – Principles of microscopic reversibility and verification - Onsager's reciprocal relations - Non-equilibrium stationary states - Prigogine's principle of maximum entropy production – Applications – Non-linear thermodynamics of irreversible processes.

Unit:3	STATISTICAL THERMODYNAMICS – I	12hours

Mathematical introduction - Theories of permutations and combinations – Laws of probability – Distribution laws – Gaussian distribution.

Maxwell-Boltzmann statistics – Thermodynamic probability – Thermodynamic probabilities of the system in equilibrium – Boltzmann expression for entropy – Sterling's approximation – State of maximum thermodynamic probability – Lagrange multipliers – Thermodynamics probabilities of systems involving energy levels – Maxwell-Boltzmann distribution law – Evaluation of alpha and beta in M-B distribution law.

Unit 4	STATISTICAL THERMODYNAMICS - II	12 hours

Bose-Einstein and Fermi-Dirac Statistics: Bose-Einstein distribution law – Entropy of Bose-Einstein gas -Plank distribution law for black body radiation – Fermi-Dirac distribution law – Entropy of a Fermi-Dirac gas – Heat capacity of electron gas and the heat capacity of metals – Helium at low temperature – Negative absolute temperature.

Heat capacities of Solids: Einstein's and Debye's theories of heat capacities of solids.

Unit5	STATISTICAL THERMODYNAMICS - III	12 hours

Partition function – definition, justification of nomenclature, microcanonical and canonical ensembles – Molecular partition function and canonical partition function – The relation between the total partition function of a molecule and the separate partition functions – Translational and rotational partition functions – Effect of molecular symmetry on rotational partition function – Ortho and para-hydrogen – Vibrational partition function. Electronic partition function. Evaluation of thermodynamic properties E, H, S, A, G, Cv and Cp from monoatomic and diatomic

ideal gas molecule partition functions – Thermodynamics properties of polyatomic ideal gases – Calculation of equilibrium constants of reactions involving ideal gases from partition functions.

Unit 6	THERMODYNAMICS AND NON-IDEAL SYSTEMS(Not for Examination)	

The zero, first and the second law of thermodynamics – Entropy – change in entropy with the change of P, V, and T – Entropy of mixing of ideal gases – Standard & physical significance - Nernst equation, Chemical equilibrium - temperature dependence, Vant-Hoff equation, Non-equilibrium thermodynamics - postulates and methodology - Phase equilibrium - Application to the three-component system. Activity and Activity coefficient: Concept - Temperature coefficient of activity - Standard states – Application of activity concept to solutions – Measurement of solvent activity from colligative properties – Determination of the activity of solute – Use of activities in the formation of reaction potentials.

	Total Lecture hours	**60 hours**

Text Book(s)

1. M.C.Gupta – Statistical Thermodynamics, New Age International, 2007
2. Kalidas, C. & Sankaranarayanan, M.V. Non-Equilibrium Thermodynamics: Principles &Applications, Macmillan India Ltd. (2002).
3. Rajaram, R. and Kuriacose, J.C., "Thermodynamics", Second Edition, S. Chand and Co., New Delhi, 1993.
4. B.R., Puri, L.R. Sharma and Madan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandhar, 2000.
5. 5. R.K. Gupta, A textbook of Physical Chemistry, Arihant publication, latest ed., 2018.

Reference Books

1	F.T. Wall – Chemical Thermodynamics, Freeman and Company, 3rd Ed., 1974.
2	S. Glasstone – Thermodynamics for Chemists, East-West Press, 1st Ed., 2008.
3	J.F. Lee, F.W. Sears and D.L. Turcotte – Statistical Thermodynamics, 2nd Ed., 1973.
4	G.W. Castellan - Physical Chemistry, 1983.
5	P. W. Atkins, Physical Chemistry; 11th Ed., Oxford University Press, Oxford, 2018.

6	Non-equilibrium thermodynamics SR De Groot, P. Mazur
7	W.J. Moore, Physical Chemistry, Orient Longman, London, 1972.
8	L.K. Nash, Elements of Chemical Thermodynamics, Addison Wesley, 1962.
9	R.P.Rastogi and R.R Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.
10	Horia Metiu, Physical Chemistry Thermodynamics, 1st Ed.,2006.
11	S.H. Maron and J.B. Lando, Fundamentals of Physical chemistry, MacMillan Publishers, New York, 1974.
12	John F. Lee Francis W. Sears Donald L. Turcotte, Statistical Thermodynamics.
13	Leonard K. Nash, Elements of statistical thermodynamics, 2nd Ed.
14	McClelland, Statistical thermodynamics, Chapman and Hall, 1973.
15	Donald A. McQuarie, Statistical Mechanics, Viva Books Pvt Ltd, 2003.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/104/106/104106094/
2	https://nptel.ac.in/courses/104/105/104105088/
3	https://nptel.ac.in/courses/104/103/104103112/

Course Designed By: Dr. M. Ilanchelian

Mapping with Programme outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	M	M	S	M
CO2	L	M	M	L	S	M
CO3	M	M	S	S	M	M
CO4	L	M	M	L	S	M

*S-Strong; M-Medium; L-Low

Course code	CHMA43D	Elective - X	L	T	P	C
Elective		**Analytical Chemistry**	**4**	**1**	**0**	**4**
Pre-requisite		Fundamentals about the analytical techniques	**Syllabus Version**		**2025-2026**	

Course Objectives:

The main objectives of this course are to:

1. To study the various methods involved in analytical techniques
2. To learn the statistical analysis
3. To learn qualitative and quantitative measurements in the absorption and emission spectroscopy
4. To apply the knowledge of electrochemistry in practical applications
5. To learn the separation process using various chromatographic techniques

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Learnt to interpret the results of the quantitative and qualitative measurements	**K3**
2	Evolved the verification strategy in the error analysis	**K5**
3	Studied the detection of various metal ions in biological systems	**K4**
4	Gained the knowledge on redox system	**K4**
5	Expertise in the detection and quantitative analysis by using various chromatographic methods	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	**Quantitative Inorganic Analysis**	**12 hours**

Theoretical basis of quantitative inorganic analysis-commonion effect solubility product, effect of acid, temperature and solvent upon the solubility of a precipitate. Super saturation-Von Weimarn

concept. Formation and treatment of precipitates-co precipitation and post-precipitation. Precipitation from homogeneous solution. Specific and selective precipitants.

Principles of acid-base, oxidation-reduction, precipitation and complexometric titrations-indicators used in such titrations. Uses of organic reagents in inorganic quantitative and qualitative analysis.

Unit2	**Data Analysis**	**12 hours**

Errors in chemical analysis – Defining terms: mean, median, accuracy and precision – classification of errors: Systematic errors and random errors. Improving accuracy of analysis – mean, standard deviation and Q-test. Comparison of results – Least square, 't'-teat, 'F'-test and 'Chi' square test

Unit 3	**Techniques in Inorganic Chemistry**	**12 hours**

Colorimetry: Theoretical and practical aspects of colorimetric analysis. Flame emission and atomic absorption spectroscopy – types of atomic spectroscopy – emission methods – absorption methods – fluorescence methods – source and atomizers for atomic spectroscopy – flame atomizers – Eletrothermal atomizers – principle and applications of atomic absorption spectroscopy. Advantages of atomic absorption spectrometry over flame photometry.

Unit4	**Electrochemical Methods of Analysis**	**12 hours**

Cyclic Voltammetry, coulometry and amperometry-principle and applications.Thermal Characterization techniques, Principle and applications of Differential Thermal Analysis (DTA), Differentials Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) Thermometric titration.

Unit 5	**Chromatographic methods**	**12 hours**

Classification – techniques and applications in column, size-exclusion, ion exchange, paper and thin layer chromatography. Gas chromatography and high performance liquid chromatography (HPLC) – principle, equipment design, sample injection system, columns, detectors and applications.

Unit 6	**Sensors, Computational Techniques, and Artificial Intelligence in Chemistry** **(Not for Examination)**	

Sensors- Introduction, Principle, Instrumentation, Classification – techniques and applications in

smart sensors, wireless sensor networks, autonomous sensors and AI enabled computational tools. AI in Analytical Chemistry – principle, model design, data handling and applications. CHEMDRAW - Writing Chemical Equation and Schemes using Software, Editing, Transporting Picture to Word Document. Construction of Molecules.

	Total Lecture hours	**60 hours**

Text Book(s)

1**.** Bakshi, U.A. and A.V. Bakshi, Electronic Instrumentation, Technical Publications, Pune, India, 2008

2. D.A.Skoog and D.M.West – Fundamentals of Analytical Chemistry

3.Chatwal Anand, Instrumental methods of Chemical Analysis, 5th edition, Himalaya Publishing House, 2002.

Reference Books

1	A.T. Vogel – A text book of Quantitative Inorganic Analysis.
2	G.D. Christian – Analytical Chemistry
3	*Willard,* H.H., Merit L.L., Dean J.A Seattle F.L., Instrumental Methods of Analysis, CBS publishing and Distribution, 2004.
4	Skoog, West, Holler and Crouch – Analytical Chemistry – An Introduction.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

https://nptel.ac.in/courses/104/105/104105084/

Course Designed By: **Dr. I. Prabha**

Mapping with Programme outcomes

COs / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	H	S	S	M	H
CO2	S	S	S	S	H	S
CO3	S	S	S	H	H	S
CO4	S	S	S	H	M	S
CO5	S	S	S	H	M	S

S-Strong; H-High; M-Medium; L-Low

Course code	CHMAV01	NMR Spectroscopy	L	T	P	C
		Value added Certificate Course	2	1	1	2
Pre-requisite		Fundamentals of NMR spectroscopy	Syllabus Version		2025-2026	

Course Objectives:

The main objectives of this course are to:

1. To understand the basic principles of NMR spectroscopy and their application in solving the structure of organic and inorganic molecules
2. To obtain hands on training for the operation of NMR spectrometer
3. To acquire the knowledge about the interpretation of spectrum

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Gain the knowledge on basic principles of NMR spectroscopy	**K2**
2	Understand the concept of NMR spectroscopy involved in organic and inorganic molecules	**K4**
3	Apply the concept NMR spectroscopy to find out the structure of known and unknown compounds.	**K6**
4	Interpret the spectrum for the characterization of structure elucidation of newly synthesized compounds.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	Nuclear Magnetic Resonance Spectroscopy	15 hours

Magnetic properties of nuclei - theory of nuclear resonance - chemical shifts - spin- spin coupling - shielding and deshielding mechanism - chemical exchange - nuclear magnetic double resonance - resonance with other nuclei - ^{13}C NMR (elementary idea only).

Unit 2	Application of NMR Spectroscopic Techniques	15 hours

Applications of NMR spectroscopy: Structure determination of organic compounds ^{1}H and ^{13}C-NMR

spectroscopic techniques. Understand the concept of 2D-NMR spectroscopic techniques.		
	Total Lecture hours	**30 hours**

Text Book(s):

1. Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Jr - Introduction to Spectroscopy: A Guide for students of organic chemistry.1979.

2. William Kemp - Organic spectroscopy, Third edition, 1991.

Reference Books

1	I.L.Finar, Organic Chemistry, Volume I, The fundamental principles, Sixth edition, Pearson education Ltd., 2014.
2	Spectroscopic identification of organic compounds, by R. M. Silverstein and G. C. Bassler. John Wiley and Sons Inc, New York and Chichester, Sussex, 2nd Edn, 1967.

Course prepared by : Dr. T. Suresh

Mapping with Programme outcomes

PO / **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO3	M	S	S	S	S	S
CO3	S	S	M	S	S	M
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMAV02	Analytical Instruments	L	T	P	C
		Value-added Certificate Course	2	1	1	2
Pre-requisite		**Basic principles of Analytical chemistry**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to:

1. To study the various methods involved in analytical chemistry
2. To learn the statistical analysis and redox reactions occurring in solution
3. To learn qualitative and quantitative measurements in the absorption and emission spectroscopy
4. To learn the separation process using chromatographic techniques

Expected Course Outcomes

On the successful completion of the course, student will be able to:

1	Students acquire knowledge about various spectral and chromatographic techniques	**K2**
2	Can able to analyze the data and can extract the results obtained from the parameters	**K4**
3	Can able to conduct and follow various kinds of reactions occurring in solution	**K5**
4	Cab able to interpret the electronic and structural properties of unknown compounds	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit 1	**Colorimetry and Spectrophotometry**	**10 hours**

Special methods of analysis – Beer-Lambert law – Colorimeters – UV-Vis spectrophotometers – Single and double beam instruments – Sources and detectors – IR spectrophotometers – Types – Attenuated total reflectance flame photometers – Atomic absorption spectrophotometers – Sources and detectors – FTIR spectrophotometers – Flame emission photometers.

Unit 2	**Chromatography**	**10 hours**

Different techniques – Gas chromatography – Detectors – Liquid chromatographs – Applications – High-pressure liquid chromatographs – Applications.

Unit3	pH Meters And Dissolved Component Analyzers	10 hours
Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors, dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer.		
	Total Lecture hours	**30hours**

Text Book(s):

1. R.S. Khandpur, 'Handbook of Analytical Instruments', Tata McGraw Hill publishing Co. Ltd., 2003.
2. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, 'Instrumental methods of analysis', CBS publishing & distribution, 1995.

Reference Books

1	C.K. Mann, T.J Vickers & W.H. Gullick, 'Instrumental Analysis', Harper and Row publishers, 1974
2	D.A. Skoog and D.M.West, 'Principles of Instrumental Analysis', Holt, Saunders Publishing, 1985
3	G.W. Ewing, 'Instrumental Methods of Analysis', McGraw Hill, 1992.

Course prepared by: Dr. K. Sundaravel

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO3	M	S	S	S	S	S
CO3	S	S	M	S	S	M
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	CHMAJA1	Current Trends in Solar Cells	L	T	P	C
		Job Oriented Certificate Course	2	1	1	2
Pre-requisite		Basic knowledge of solar cell	Syllabus Version		2025-2026	

Course Objectives

The main objectives of this course are to

1. Create awareness of the advanced technology of third-generation solar cells
2. To know how the energy conversion process occurs in the device
3. Provide knowledge on the fabrication of portable devices and measure their performance
4. Model the new device for commercialization

Expected Course Outcomes

On the successful completion of the course, students will be able to:

1	To understand various types of renewable energy resources, its working principle	**K1, K2**
2	Understand the need for solar energy and its impact on society	**K2, K3, K4**
3	Analyze the device performances	**K1, K3, K5**
4	Develope new devices and commercialization ideas	**K1, K2**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit1	DYE / QUANTUM-DOT SENSITIZED SOLAR CELLS	15 hours

Need of renewable energy sources - solar energy, nature of solar radiation, components - Classification of Photovoltaic and its principles - Dye-sensitized solar cells (DSSC) / Quantum – dot sensitized solar cells (QDSSC) – Introduction - working principle, fabrication, and applications.

Unit 2	DEVICE PERFORMANCE AND ITS PARAMETERS	15 hours

Evaluation parameters and factors affect the performance of photovoltaic devices. DSSC/QDSSC - Characterization of photoelectrochemical properties – Electrochemical impedance

spectroscopy – dark current measurement – Open-circuit voltage decay: IV characteristics – incident photon-to-current conversion efficiency (IPCE) - intensity modulated photovoltage spectroscopy (IMPV) - lifetime measurements – Overview of Perovskite solar cells – introduction, working and fabrication – National and International solar panel production companies.

	Total Lecture hours	**30 hours**

Reference Books

1	Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd., 2008.
2	Jha A.R., "Solar Cell Technology and Applications", CRC Press, 2010.
3	Partain L.D., Fraas L.M., "Solar Cells and Their Applications", 2nd ed., Wiley, 2010.
4	Garg H. P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, New Delhi, 1997
5	Michael Grätzel, J. Photochemistry and Photobiology C: Photochemistry Reviews 4 (2003) 145–153, Solar Energy Conversion by Dye-Sensitized Photovoltaic Cells, Inorg. Chem., Vol. 44, No. 20, 2005 6841-6851.
6	Dye Sensitized Solar Cells by K. Kalyansundaram, EPFL Press, A Swiss academic publisher distributed by CRC press.
7	Jiang Wu, Zhiming M. Wang, "Quantum Dot Solar Cells" (2014) Springer New York, NY.
8	Aparna Thankappan, Sabu Thomas, "Perovskite Photovoltaics: Basic to Advanced Concepts and Implementation" (2018) Academic Press.
9	Kunwu Fu, Anita Wing Ho-Baillie, Hemant Kumar Mulmudi, Pham Thi Thu Trang, "Perovskite Solar Cells: Technology and Practices" (2019) CRC Press.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

https://nptel.ac.in/courses/113104084 - NOC:Solar Photovoltaics: Principles, Technologies & Materials, IIT Kanpur, Dr. Ashish Garg

https://nptel.ac.in/courses/115107116 - NOC:Solar Photovoltaics Fundamentals, Technology And Applications, IIT Roorkee, Prof. Soumitra SataPathi

Course Designed By: **Dr. S.N. Karthick**

Mapping with Programme outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO3	M	S	S	S	S	S
CO3	S	S	M	S	S	M
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code	**CHMAJA2**	**Overview of Energy Storage Devices**	**L**	**T**	**P**	**C**
		Job Oriented Certificate Course	2	1	1	2
Pre-requisite		**Basic knowledge of galvanic and electrolytic cells**	**Syllabus Version**		**2025-2026**	

Course Objectives

The main objectives of this course are to:

1. To provide knowledge about the basic concept of batteries and supercapacitor
2. To train the students in the fabrication of the battery and supercapacitor prototypes
3. To express their expertise in the evaluation of the battery and supercapacitor performance
4. Gathering knowledge about the safety measures

Expected Course Outcomes

On the successful completion of the course, students will be able to:

1	Know the basic electrochemistry behind the battery and supercapacitor	**K1**
2	Understand the mechanism - batteries and supercapacitor	**K1, K3, K4**
3	Construct and troubleshoot the factors affecting the battery and supercapacitor performance.	**K2, K5**
4	Make new structured devices and commercialization ideas	**K2, K4, K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create		
Unit 1	**ELECTROCHEMISTRY BASICS**	**10 hours**
Introduction to electrochemistry, potentials, and thermodynamics of cells, galvanic and electrolytic cells, the kinetics of electrochemical reactions, mass transfer by migration and diffusion, and non-Faradaic and Faradaic reactions.		
Unit 2	**BATTERIES**	**10 hours**
Basics of Primary and Secondary cells - materials used in various components (electrodes, electrolytes, separator, and binders) of different types of batteries: Lead-acid batteries, Zinc–ion batteries, Li-ion batteries. – its Construction, working, and applications - Parameters in Evaluation and factors that affect the performance of the batteries - Manufacturing of batteries - Battery safety and Abuse tolerance. Manufacturing of Batteries on a large scale (National and International level).		
Unit3	**SUPERCAPACITOR**	**10 hours**
Fundamentals of electrochemical supercapacitors - electrode and electrolyte interfaces and their capacitances - Types of supercapacitors: Electrochemical Double-Layer Capacitors- Psuedocapacitors - Advantages, disadvantages, and applications - design, fabrication, operation and evaluation (charge-discharge, energy/power density, Impedance, cycles, Ragone plot, etc.). Manufacturing of supercapacitors on a large scale (National and International level).		
	Total Lecture hours	**30 hours**

Reference Books

1	Bard, A. J.; Faulkner, L. R. Electrochemical Methods: Fundamental and Applications, second edition., John Wiley & Sons: Hoboken, NJ, 2001.
2	Fuller, Thomas Francis, Harb, John Naim, Electrochemical engineering, First edition. John Wiley & Sons: Hoboken, NJ,2018.
3	Eliezer Gileadi, Physical Electrochemistry -Fundamental, Techniques and Applications, John Wiley & Sons: Hoboken, NJ, 2011.
4	Bagotsky, V. S. (Vladimir Sergeevich), Fundamentals of electrochemistry, second edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2006.
5	Yuping Wu, LITHIUM-ION BATTERIES Fundamentals and Applications, CRC Press

	Taylor & Francis Group. 2015.
6	Conway, B. E. Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications; Kluwer Academic Plenum Publisher: New York, 1999.
7	Aiping Yu, Victor Chabot, and Jiujun Zhang, Electrochemical Supercapacitors for Energy Storage and Delivery - Fundamentals and Applications, CRC Press Taylor & Francis Group. 2013.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
https://nptel.ac.in/courses/104106137 - NOC: Elementary Electrochemistry, IISER Mohali, Prof. Angshuman Roy Choudhury	
https://nptel.ac.in/courses/113105102 - NOC: Electrochemical Energy Storage, IIT Kharagpur, Prof. Subhasish Basu Majumder	
Course Designed By: **Dr. S.N. Karthick**	

Mapping with Programme outcomes

PO / **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	S	S	S	S
CO3	M	S	S	S	S	S
CO3	S	S	M	S	S	M
CO4	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low

----23 - 886*		L	T	P	C**
AUDIT	**HEALTH & WELLNESS**	**0**	**0**	**2**	**1**

*(First four digits in the subject code is branch code and Seventh digit is Semester)

** Health & Wellness has one credit for the third semester only and it has no credits for other semesters.

Skill Areas:

Physical Fitness, Nutrition, Mental Health, Awareness on Drug addiction and its effects

Purpose:

The Health & Wellness course focuses on teaching the elements of physical, mental, emotional, social, intellectual, environmental well-being which are essential for overall development of an individual. The course also addresses the dangers of substance abuse and online risks to promote emotional and mental health.

Learning Outcomes:

Upon completion of the Health & Wellness course, students will be able to:

1. Demonstrate proficiency in sports training and physical fitness practices.
2. Improve their mental and emotional well-being, fostering a positive outlook on health and life.
3. Develop competence and commitment as professionals in the field of health and wellness.
4. Awareness on drug addiction and its ill effects

Focus:

During the conduct of the Health & Wellness course, the students will benefit from the following focus areas:

1. Stress Management.
2. Breaking Bad Habits.
3. Improving Interpersonal Relationships.
4. Building Physical Strength & Inner Strength.

Role of the Facilitator:

The faculty plays a crucial role in effectively engaging with students and guiding them towards achieving learning outcomes. Faculty participation involves the following areas:

1. **Mentorship & Motivation:** The Facilitator mentors students in wellness and self-discipline while inspiring a positive outlook on health. Faculty teach stress management, fitness, and daily well-being.
2. **Promoting a Safe and Inclusive Environment:** The facilitator ensures a safe, inclusive, and respectful learning environment for active student participation and benefit.
3. **Individualised Support and Monitoring Progress:** The facilitator plays a crucial role in providing personalized support, monitoring and guidance to students.

Guided Activities:

In this course, several general guided activities have been suggested to facilitate the achievement of desired learning outcomes. They are as follows:

1. Introduction to Holistic Well-being.
2. Holistic Wellness Program- Nurturing Body and Mind
3. Breaking Bad Habits Workshop.
4. Improving the elements of physical, emotional, social, intellectual, environmental and mental well-being.
5. Creating situational awareness, digital awareness.
6. Understanding substance abuse, consequences and the way out.

Period Distribution

The following are the guided activities suggested for this Audit course.

The Physical Director should plan the activities by the students.

Arrange the suitable Mentor / Guide for the wellness activities.

Additional activities and programs can be planned for Health and Wellness.

S.No	Guided Activities	Period
1	**Introduction to Holistic Well-being** 1. Introduce the core components of Health & Well-being namely Physical, mental and emotional well-being 2. Provide worksheets on all the four components individually and explain the interconnectedness to give an overall understanding.	
2	**Wellness Wheel Exercise (Overall Analysis)**	

	• Guide students to assess their well-being in various life dimensions through exercises on various aspects of well – being, and explain the benefits of applying wellness wheel. • Introduce Tech Tools: • Explore the use of technology to support well-being. • Introduce students to apps for meditation, sleep tracking, or healthy recipe inspiration.	
3	**Breaking Bad Habits (Overall Analysis)** • Open a discussion on bad habits and their harmful effects. • Provide a worksheet to the students to identify their personal bad habits. • Discuss the trigger, cause, consequence and solution with examples. • Guide them to replace the bad habits with good ones through worksheets.	
4	**Physical Well-being** **1. Fitness** Introduce the different types of fitness activities such as basic exercises, cardiovascular exercises, strength training exercises, flexibility exercises, so on and so forth. (Include theoretical explanations and outdoor activity). **2. Nutrition** Facilitate students to reflect on their eating habits, their body type, and to test their knowledge on nutrition, its sources and the benefits. **3. Yoga & Meditation** Discuss the benefits of Yoga and Meditation for one's overall health. Demonstrate different yoga postures and their benefits on the body through visuals (pictures or videos)	

	4. Brain Health Discuss the importance of brain health for daily life. Habits that affect brain health (irregular sleep, eating, screen time). Habits that help for healthy brains (reading, proper sleep, exercises). Benefits of breathing exercises and meditation for healthy lungs. **5. Healthy Lungs** Discuss the importance of lung health for daily life. Habits that affect lung health (smoking, lack of exercises). Benefits of breathing exercises for healthy lungs. **6. Hygiene and Grooming** Discuss the importance of hygienic habits for good oral, vision, hearing and skin health. Discuss the positive effects of grooming on one's confidence level and professional growth. **Suggested Activities (sample):** **Nutrition:** Invite a nutritionist to talk among the students on the importance of nutrition to the body or show similar videos shared by experts on social media. Organize a 'Stove less/fireless cooking competition' for students where they are expected to prepare a nutritious dish and explain the nutritive values in parallel.	
5	**Emotional Well-being** **1. Stress Management** Trigger a conversation or provide self-reflective worksheets to identify the stress factors in daily life and their impact on students' performance. Introduce different relaxation techniques like deep breathing, progressive muscle relaxation, or guided imagery. (use audio recordings or visuals to guide them through these techniques). After practicing the techniques, have them reflect on how these methods can help manage stress in daily life. **2. Importance of saying 'NO'.**	

	Explain the students that saying 'NO' is important for their Physical and mental well-being, Academic Performance, Growth and Future, Confidence, Self-respect, Strong and Healthy Relationships, building reputation for self and their family (avoid earning a bad name). Factors that prevent them from saying 'NO'. How to practice saying 'NO". **3. Body Positivity and self-acceptance** Discuss the following with the students. • What is body positivity and self-acceptance? • Why is it important? • Be kind to yourself. • Understand that everyone's unique. **Suggested Activities(Sample):** (Importance of saying 'NO') Provide worksheets to self-reflect on... ...how they feel when others say 'no' to them ...the situations where they should say 'no' Challenge students to write a song or rap about the importance of saying no and how to do it effectively. Students can perform their creations for the class.	
6	**Social Well-Being** **1. Practicing Gratitude** Discuss the importance of practicing gratitude for building relationships with family, friends, relatives, mentors and colleagues Discuss how one can show gratitude through words and deeds. Explain how practicing gratitude can create 'ripple effect'. **2. Cultivating Kindness and Compassion** Define and differentiate between kindness and compassion. Explore practices that cultivate these positive emotions. Self-Compassion as the Foundation.	

	The power of small gestures. Understanding another's perspective. The fruits of compassion. **3. Practising Forgiveness** Discuss the concept of forgiveness and its benefits. Forgiveness: What is it? and What it isn't? Benefits of forgiveness. Finding forgiveness practices. **4. Celebrating Differences** Appreciate the value of individual differences and foster inclusivity. The World: A Tapestry of Differences (cultures, backgrounds, beliefs, abilities, and appearances). Finding strength in differences (diverse perspectives and experiences lead to better problem-solving and innovation). Celebrating differences, not ignoring them (respecting and appreciating the unique qualities). Activities for celebrating differences (share culture, learn about others, embrace new experiences). **5. Digital Detox** **Introduce the students to:** The concept of a digital detox and its benefits for social well-being. How to disconnect from devices more often to strengthen real-world connections. **<u>Suggested Activities (sample)</u>**: (Practicing Gratitude) Provide worksheets to choose the right ways to express gratitude. Celebrate 'gratitude day' in the college and encourage the students to honour the house keeping staff in some way to express gratitude for their service.	
7.	**Intellectual Well-being** **1. Being a lifelong Learner** **Give students an understanding on:** The relevance of intellectual well-being in this 21st century to meet	

	the expectations in personal and professional well-being The Importance of enhancing problem-solving skills Cultivating habits to enhance the intellectual well-being (using the library extensively, participating in extra-curricular activities, reading newspaper etc.) **2. Digital Literacy** **Discuss:** The key aspects of digital literacy and its importance in today's world. It is more than just liking and sharing on social media. The four major components of digital literacy (critical thinking, communication, problem-solving, digital citizenship). Why is digital literacy important? Boosting one's digital skills. **3. Transfer of Learning** Connections between different subjects – How knowledge gained in one area can be applied to others. **Suggested Activities(sample):** Intellectual Well-being. Provide worksheets to students for teaching them how to boost intellectual well-being. Ask the students to identify a long-standing problem in their locality, and come up with a solution and present it in the classroom. Also organize an event like 'Idea Expo' to display the designs, ideas, and suggestions, to motivate the students to improve their intellectual well-being.	
8	**Environmental Well-being** 1.The Importance of initiating a change in the environment. **The session could be around:** Defining Environmental well-being (physical, chemical, biological, social, and psychosocial factors) – People's behaviour, crime, pollution, political activities, infra-structure, family situation etc. Suggesting different ways of initiating changes in the environment (taking responsibility, creating awareness, volunteering,	

	approaching administration). **Suggested Activities (sample):** Providing worksheets to self-reflect on how the environment affects their life, and the ways to initiate a change. Dedicate a bulletin board or wall space (or chart work) in the classroom for students to share their ideas for improving environmental well-being. Creating a volunteers' club in the college and carrying out monthly activities like campus cleaning, awareness campaigns against noise pollution, (loud speakers in public places), addressing anti-social behaviour on the campus or in their locality.	
9	**Mental Well-being** **1. Importance of self-reflection** **Discuss:** Steps involved in achieving mental well-being (self-reflection, self-awareness, applying actions, achieving mental well-being). Different ways to achieve mental well-being (finding purpose, coping with stress, moral compass, connecting for a common cause). The role of journaling in mental well-being. **2. Mindfulness and Meditation Practices** Benefits of practicing mindful habits and meditation for overall well-being. **1. Connecting with nature** Practising to be in the present moment – Nature walk, feeling the sun, listening to the natural sounds. Exploring with intention – Hiking, gardening to observe the nature. Reflecting on the emotions, and feeling kindled by nature. **2. Serving people** Identifying the needs of others. Helping others. Volunteering your time, skills and listening ear. Finding joy in giving. **3. Creative Expressions**	

	Indulging in writing poems, stories, music making/listening, creating visual arts to connect with inner selves. **Suggested Activities(Sample):** (Mindfulness and Meditation) – Conducting guided meditation every day for 10 minutes and directing the students to record the changes they observe.	
10	**Situational Awareness (Developing Life skills)** **1. Being street smart** **Discuss:** Who are street smarts? Why is it important to be street smart? Characteristics of a street smart person: Importance of acquiring life skills to become street smart – (General First-aid procedure, CPR Procedure, Handling emergency situations like fire, flood etc). **2. Digital Awareness** **Discuss:** Cyber Security Information Literacy Digital Privacy Fraud Detection **Suggested Activities** (sample): (Street Smart) Inviting professionals to demonstrate the CPR Procedure Conducting a quiz on Emergency Numbers	
11	**Understanding Addiction** **Plan this session around:** Identifying the environmental cues, triggers that lead to picking up this habit. Knowing the impact of substance abuse – Adverse health conditions, social isolation, ruined future, hidden financial loss and damaging the family reputation. Seeking help to get out of this addiction. **Suggested Activities**:	

	Provide Worksheets to check the students' level of understanding about substance addiction and their impacts. Share case studies with students from real-life. Play/share awareness videos on addiction/de-addiction, experts talk. *Conduct awareness programmes on Drugs and its ill effects. (Arrange Experts from the concerned government departments and NGOs working in drug addiction issues) and maintain the documents of the program.	

Closure:

Each student should submit a Handwritten Summary of their Learnings & Action Plan for the future.

Assessments:

- Use Self-reflective worksheets to assess their understanding.
- Submit the worksheets to internal audit/external audit.
- Every student's activities report should be documented and the same have to be assessed by the Physical Director with the mentor. The evaluation should be for 100 marks. No examination is required.

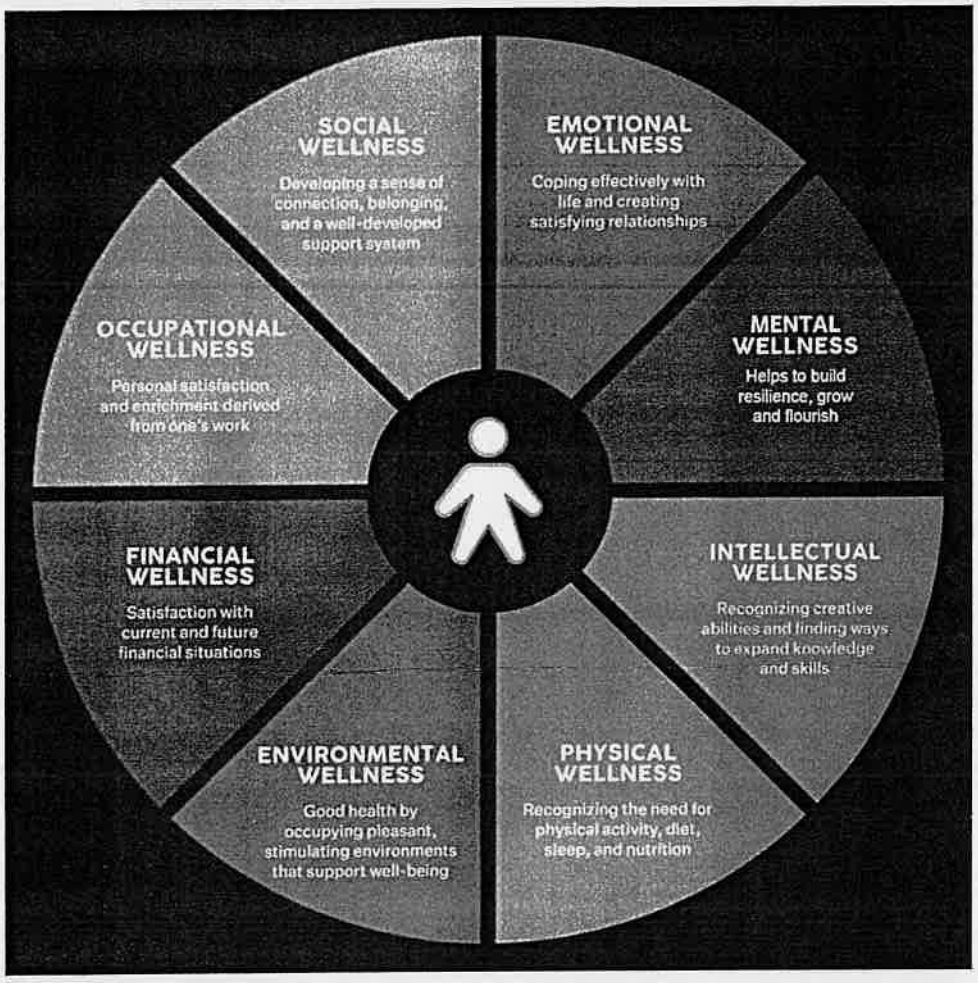
Scheme of Evaluation

Part	Description	Marks
A	Report	40
B	Attendance	20
C	Activities (Observation During Practice)	40
Total		100

References/Resource Materials:

The course acknowledges that individual needs for references and resources may vary. However, here are some general reference materials and resources that may be helpful:

1. **The Well-Being Wheel:**



2. **Facilities & Spaces:** Some activities may require access to specific facilities, resources or spaces. Students may need to coordinate with the college administration to reserve these as required.
3. **Online Resources:**
    1. United Nations Sustainable Development Goals - Goal 3 - Good Health & Well-Being: https://www.un.org/sustainabledevelopment/health/
    2. Mindfulness and Meditation: Stanford Health Library offers mindfulness and meditation resources: https://healthlibrary.stanford.edu/books-resources/mindfulness-meditation.html

3. Breaking Bad Habits: James Clear provides a guide on how to build good habits and break bad ones: https://jamesclear.com/habits
4. 6 Ways to Keep Your Brain Sharp https://www.lorman.com/blog/post/how-to-keep-your-brain-sharp
5. What Is Social Wellbeing? 12+ Activities for Social Wellness https://positivepsychology.com/social-wellbeing/
6. How Does Your Environment Affect Your Mental Health? https://www.verywellmind.com/how-your-environment-affects-your-mental-health-5093687
7. How to say no to others (and why you shouldn't feel guilty) https://www.betterup.com/blog/how-to-say-no