M. Sc. Chemistry

Syllabus

UNIVERSITY DEPARTMENT

Program Code: CHMA

2021 – 2022 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

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 2021 – 22 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
CHMA13A	Organic Chemistry-I Reaction Mechanisms	4	65	-	50	50	100
CHMA13B	Inorganic Chemistry-I Coordination Chemistry	4	60	-	50	501	100
CHMA13C	Physical Chemistry-I Electro Chemistry & Photo Chemistry	4	60	-	50	50	100
CHMA1EA	Elective – I Physical methods in chemistry	4	60		50	50	100
CHMA1EB	Elective II Water treatment and Polymers	4	60		50	50	100
CHMA1EC	Elective III	4	60		50	50	100
CHMA13P	Practical I	4	-	60	50	50	100
GS06	Supportive I	2	25		25	25	50
Total		30			375	375	750
SECOND SEMESTER							
CHMA23A	Organic Chemistry II	4	75		50	50	100
CHMA23B	Inorganic Chemistry II	4	60		50	50	100
CHMA23C	Physical Chemistry II	4	75		50	50	100
CHMA2EA	Elective IV	4	75		50	50	100
CHMA2EB	Elective V	4	60		50	50	100
CHMA2EC	Elective VI	4	60		50	50	100
CHMA23P	Practical II	4	-	75	50	50	100
GS73	Supportive II	2	25		25	25	50
Total		22		6	375	375	750
THIRD SEMESTER							
CHMA33A	Organic Chemistry III	4	65		50	50	100
CHMA33B	Inorganic Chemistry III	4	60		50	50	100
CHMA33C	Physical Chemistry III	4	60		50	50	100
CHMA3EA	Elective VII	4	60		50	50	100
CHMA3EB	Elective VIII	4	60		50	50	100
CHMA3EC	Elective IX	4	60		50	50	100
CHMA33P	Practical III	4	-	60	50	50	100
GS	Supportive III	2	25		25	25	50
Total		22			375	375	750

FOURTH SEMESTER							
CHMA43A	Organic Chemistry IV	4	75		50	50	100
CHMA43B	Inorganic Chemistry IV	4	60		50	50	100
CHMA43C	Physical Chemistry IV	4	75		50	50	100
CHMA43D	Analytical Chemistry	4	60		50	50	100
CHMA4LV	Project Work	8	-		50	150	200
	SWAYAM MOOCs Online 4 weeks course	2	-			50	50
Total		26			150	500	650
Grand Total		90			561	1739	2300

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

First Semester

Course code	CHMA13A	TITLE OF THE COURSE	L	T	P	C
Core		Organic Chemistry –I	4	1	-	4
Pre-requisite		Chemical reactions & their mechanism	Syllabus Version		2021-2022	

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 of 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 the various reactions like electrophilic, nucleophilic, addition, elimination, oxidation, reduction reactions	K2
2	To understand the basics of electrophilic, nucleophilic, addition, elimination, oxidation, reduction reaction through the name reactions.	K4
3	To apply the mechanism in chemical reactions to predict the reaction pathway.	K5
4	To assessment different types of reaction mechanism involving in chemical reaction during their project work.	K3
5	To learn the concept of aromaticity in organic and inorganic compounds.	K4

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

Unit:1 **Aliphatic and aromatic nucleophilic substitution reactions:** **13-- hours**

Bonding - structure and reactivity – HSAB concept (hard and soft acid base theory) - 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 and 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:** **13-- 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) disubstituted formamides (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 - Napieralski rection) - haloalkylation - aminoalkylation and amido alkylation - thioalkylation -acylation with nitriles (Hoesch reaction) - cyanation - hydroxylation.

Unit:3	**Aromaticity:**	**13-- hours**
Aromaticity- Concept of aromaticity - aromaticity of benzenoid and non benzenoid compounds - effect of aromaticity on bond lengths, resonance, resonance energies, electronic absorption spectra and induced ring currents - Huckel's rule - structure and synthesis of azulenes, ferrocenes, sydnones, tropolones, fulvenes and annulenes.		
Unit:4	**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 reaction, Meerwein-Pondorf reduction, Grignard reactions, Aldol, Claisen, Stobbe, Darzens, Wittig, Thorpe and benzoin condensations - Cannizarro reaction. 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, SeO_2, $Hg(OAc)_2$, and $Pb(OAc)_4$- 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.		
Unit:6	**Alicyclic compounds: (not for final examination)**	**2 hours**
Nomenclature, Cycloalkanes and cycloalkenes; Diels-alder reaction, Classification of monocyclic systems, Baeyer strain theory. Small and common rings, Conformational analysis. Medium-ring compounds, large ring compounds.		
	Total Lecture hours	**65-- hours**

Text Book(s)

1. Jerry March, Advanced Organic Chemistry - Reactions, Mechanism and Structure, Wiley-Interscience, 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, Mc.Graw-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	

Mapping with Programme outcomes

COs	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 on chemical bonding	Syllabus Version		2021-2022	

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.	K1
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 **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.

Unit:2 **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 **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.

Unit:4 **11 hours**

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.

Unit:5		**11 hours**

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.

Unit:6	**(not for final examination)**	**2 hours**

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 5. 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	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		Core	4	1	0	4
Pre-requisite		Basic principle of electrochemistry	Syllabus Version		2021-2022	

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	12 hours

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	12 hours

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.

Unit:3	ELECTROCHEMISTRY - III	12 hours

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**	**11 hours**

Absorption and emission of radiation – Theories – Spontaneous and induced emission –Laser – Franck Condon principle - Type 1 & 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 & NANOTECHNOLOGY**	**11 hours**

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.

Unit:6	**Recent trends in photochemical and electrochemical reactions: (Not for Examination)**	**2 hours**

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	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	PHYSICAL METHODS IN CHEMISTRY	L	T	P	C
Elective		Elective	4	1	0	4
Pre-requisite		Fundamentals about the electromagnetic spectrum	Syllabus Version		2021-2022	

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 material.

Expected Course Outcomes:

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

1	To know the fundamental concepts and application of various analytical techniques.	K2
2	To acquire intense knowledge about the basic principles, instrumentation and applications of UV-Visible, Raman, Rotational, Vibrational and Electronic spectroscopy.	K3
3	To gain the in-depth knowledge of concepts in radiation chemistry and to learn about the surface morphology (particle shape and size) characterization of materials using various advanced instrumentation techniques.	K4
4	To learn how to interpret the data for well-known compounds, which is helpful to predict 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 - Anharmonic oscillator - Vibrations of polyatomic molecules – Fundamental vibrations and overtones – Hot bands – 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 ELECTRONICS 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 of characterization only.

Unit:6	SPECTROSCOPIC TOOLS FOR NANOMATERIALS: (Not for Final Examination)	2 hours

Confocal Laser-Scanning Microscopy - Scanning Near-Field Optical Microscopy - Two-Photon Fluorescence Microscopy - Dynamic Light Scattering - Brewster Angle Microscopy - Photoelectron Spectroscopy – UV-Visible Spectroscopy - Atomic Absorption Spectroscopy - Inductively Coupled Plasma Spectroscopy - Fluorescence Spectroscopy - Localized Surface Plasmon Resonance - Nanocalorimetry - Brunauere-Emmette-Teller Method - Nanoparticle Tracking Analysis.

	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	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	2021-2022		

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**	**12-- hours**

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**	**12-- hours**

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**	**12-- hours**

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 & advantages.

Unit:4	**Environmental Pollution**	**11-- hours**

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)**	**11-- hours**

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.

Unit:6	**Indian Medicinal Plants** (not for final examinations)	**2 hours**

Hibisous Rosa Sinesis: Adathoda vasica: Ocimum Sanctum: Mangifera Indica: Azadirachta Indica: Phyllanthys Niruri: Solanum Trolobatum: Grasses; Green

	Total Lecture hours	**60-- hours**

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.V.Kaveri

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	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 II	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		2021-2022	

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

Unit:1	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 & 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.

Unit:4	Applications and Tools of Industry 4.0	12 hours

Applications of IoT – Manufacturing – Healthcare – Education – Aerospace and Defense – Agriculture – Transportationa 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	12 hours

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	**60 hours**
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	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	ORGANIC PRACTICALS	L	T	P	C
Core		ORGANIC PRACTICALS	0	0	6	4
Pre-requisite		Knowledge about the properties of an organic compound	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

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

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 which meets the industrial standards	K3
3	To understand the basic reaction conditions such as solubility, hydrolysis, acetylation, bromination, nitration to 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.

Quantitativeanalysis	**15 hours**

Estimation of phenol, aniline and reducing sugar

Single stagepreparation:	**15 hours**

(i) Benzoic acid from ethylbenzoate
(ii) Acetanilide fromaniline
(iii) Acetylsalicylic acid from salicyclicacid
(iv) p-Bromoacetanilide fromacetanilide
(v) Picric acid fromphenol

Double stagepreparation:	**15 hours**

(i) Symmetrical tribromobenzene from aniline
(ii) *p*-Nitro aniline fromacetanilide

Total Lecture hours	**60 hours**

Text Book :

1. "N. S. Gnana Prakasam, G. Ramamurthy, Organic chemistry Manual, S. Viswanathan Co.,Ltd.

Reference Books

1. Vogel'sTextbookofpracticalorganicchemistry,5th edition,PrenticeHall,2008
2. Raj K Bansal, Laboratory manual of organic chemistry, III edn, New age international (p) Ltd, 1996

Course Designed By: Dr. M. V. Kaveri

Mapping with Programme outcomes

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

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

Course code	GS06	CHEMISTRY IN CONTEXT	L	T	P	C
Supportive			2	0	0	2
Pre-requisite		Awareness on Environmental pollution	Syllabus Version		2021-2022	

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 man made 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

Unit:1	**6 hours**

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	**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	**6 hours**

Energy - Introduction- Definition-Sources of energy- Types of energy- Renewable energy sources-Non-renewable energy sources- Nuclear energy-Applications.

Unit:4	**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.V.Kaveri	

Mapping with Programme outcomes

PO / CO	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		Natural Products, Proteins, Nucleic acids, Stereochemistry, Molecular rearrangements and Heterocyclic Compounds	4	1		4
Pre-requisite		Basic concept about Natural products & stereo chemistry	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. To understand the versatile knowledge about the isolation, synthesis, bio-synthesis and elucidation of various naturalproducts.
2. To understand the basic concept of conformational analysis and stereochemistry.
3. To know about the principles of molecular rearrangements and it is essentially involving in the namereactions.
4. To acquire basic knowledge about the heterocyclic chemistry involving in natural products.

Expected Course Outcomes:

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

1	To remember the basic values of natural products such as terpenoids, amino acids, proteins and nucleic acids. To keep in mind the basic knowledge about conformational analysis as well as stereochemistry.	K1
2	To understand the concept of conformational analysis and also the stereochemistry of the organic molecules. To get an idea about heterocyclic chemistry in various natural products and molecular rearrangements involving in named reactions.	K2
3	To apply the concept of stereochemistry in optically active organic molecules. To gain the interest on uses of natural products such as amino acids, proteins and nucleic acids in the human day to day life.	K3
4	To analyze the geometry of the molecules as well as the stereochemistry of the organic molecules. To analyze the functions of the natural products suchas proteins, amino acids and nucleic acid.	K4

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

Unit:1	Terpenoids:	13 hours

Isolation and classification - general methods to elucidate the structure of terpenoids - methods of structure elucidation and synthesis as applied to zingiberine - eudesmol - caryophyllene - abietic acid - santonin - biosynthesis of terpenes.

Unit:2	Amino acids, Proteins and Nucleic acids:	13 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:3	Conformational Analysis and Stereochemistry:	13 hours

Geometrical and optical isomers : R, S and E, Z configurational notations - different types of optical isomerism including dissymmetric over crowded molecules - stereochemistry of sulphur and nitrogen compounds - configurations - geometrical isomerism and configurations in mono and bicyclic ring systems - conformational analysis of acyclic system - cyclohexanes - perhydrophenantharene - decalins - carbohydrates - 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 - Favorski - Wolff - Benzidine - Claisen - Cope rearrangement, Stevens-Wittig-Sommelet- Grovenstein-Zimmermann (Di-Pi methane rearrangement) rearrangements - non-cyclic rearrangements - Chapman and Wallach rearrangement.

Unit:5	**Heterocyclic compounds**	**12 hours**

Structure - synthesis and reactions of the following systems

a) Small ring Heterocycles - Three membered and four membered Heterocycles- aziridines, oxiranes, thiranes, azetidines, oxitanes andthietanes.

b) Benzo fused Heterocycles – benzofurans, benzothiophenes, carbazole - chromone - flavanones - flavones - flavonols –isoflavones.

Unit:6	**Carbohydrates (Not for Final Examination)**	**2 hours**

Determination of the configuration of the monosaccharides, Ring structure of the monosaccharides, Methods for determining the size of sugar rings, Conformational analysis, isoPropylidene derivatives of the monosaccharides, Vitamin C, Disaccharides, Trisaccharides, Polysaccharides, Photosynthesis, Glycosides.

	Total Lecture hours	**75 hours**

Text Book(s):

1. I. L. Finar, Organic chemistry, vol. I and vol.II.

2. R. K. Bansal, Heterocyclic Chemistry; 3rd Ed., Wiley Eastern Ltd, New Delhi,1999.

Reference Books

1	Koji Nakanishi, Toshio Goto and Sho Ito, Natural product chemistry, vol. I, Academies press,1974.
2	A.A.Newman, Chemistry of Terpenes and Terpenoids**.** Ed. Academic Press, New York, 1972.
3	E. L. Eliel, Stereochemistry of carbon compounds, Mc Graw Hill, 1962.
4	P.Ramesh, Basic principles of Organic Stereochemistry, Meenupublication,2005.
5	J. A. Joule, K. Mills and G. F. Smith, Heterocyclic Chemistry,3rd Edition, Chapman & Hall, London, 1995.
6	Thomas L. Gilchrist, Heterocyclic Chemistry. Third Edition, Addison Wesley Longman: Essex. 1997.

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

1	https://nptel.ac.in/courses/104/105/104105104/
2	https://nptel.ac.in/courses/104/101/104101005/
3	https://nptel.ac.in/courses/104/103/104103071/
4	https://nptel.ac.in/courses/104/105/104105034/

5	https://nptel.ac.in/courses/104/105/104105086/
Course Designed By: Dr. A. Kannan	

Mapping with Programme outcomes

COs	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		Bioinorganic Chemistry	4	1		4
Pre-requisite		Basic Notions of inorganic chemistry in biological systems	Syllabus Version	2021-2022		

Course Objectives:

The main objectives of this course are to:

1. To understand the key role of various elements in the living systems.
2. To acquire basic knowledge about the structure and functions of certain metallo-enzymes.
3. To gain insight into the small molecules binding and transport mechanism 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	To understand the key function of metal ions such as manganese, iron, cobalt, nickel, copper, zinc, molybdenum etc. in biological system, in particular in metalloenzymes.	K2
2	To 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.	K2 & K4
3	To gain knowledge about themedically-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) Ru and Pt complexes in cancer therapy. This would motivate the students to pursue89 their research in the field of medicinal chemistry.	K2 & K4
4	To equip the student to answer the bioinorganic chemistry related questions which are frequently aroused in competitive examinations.	K4

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

Unit:1	Metals in Biology	12-- hours

Metals and Non-metals in biological systems - Essential and trace elements - Role of different metal ions in biological systems - Sodium-Potassium pump – Calcium ATbase pump Ferritin – Hemosiderin- Transferrin- Blue copper proteins - Catecholase - Photosynthesis: Chlorophyll - Photosystem-I (PS-I) & II (PS-II) - Structure-function relationship.

Unit:2	Structure and Function of Various Metalloenzymes	12-- hours

Metalloenzymes - Definition - Examples - Active site structure and mechanism of action of - Carboxy peptidase-A and Carbonic anhydrase - Structure and function of Superoxide dismutase (SOD) (Fe-SOD, Mn-SOD, Cu-Zn couple SOD and Ni-SOD), Peroxidase and catalase enzymes - Xanthine oxidase – Nitrogenase, Hydrogenase, Urease

Unit:3	Heme and Non-heme Metalloenzymes	12-- hours

Phorphyrin system - Structure and functions of Hemoglobin and Myoglobin - Dioxygen binding, transport and utilization - Hemocyanin - Hemerythrin - Synthetic oxygen carriers - Vitamin B_{12} co-enzyme - Non-heme iron-sulphur proteins - Ferridoxins - Rubredoxins – Cytochrome. a,b,c, cytochrome P450, Cytochrome C oxidase, sMMO, pMMO.

Unit:4	**Metals in Medicine**	**11-- hours**
Binding of metal ions and complexes to biomolecules, Types of binding - Nucleic acid structures - Fundamental interactions with nucleic acids - Binding interactions of tris-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.		
Unit:5	**Drug Discovery and Design**	**11-- 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.		
Unit:6	**Metal Based Drugs (Not for final examination)**	**2 hours**
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

COs	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	QUANTUM CHEMISTRY AND GROUP THEORY		4	1	0	4
Pre-requisite	Understanding the physical & mathematical aspects of quantum mechanics		Syllabus Version	2021-2022		

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, student will be able to:

1	Understand the concepts of classical and quantum mechanics, to 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 and multielectron systems and to review the group theoretical approach towards 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 eigen values - 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 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 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.

Unit:3	APPLICATIONS OF QUANTUM CHEMISTRY	12 hours

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 principles – symmetric and antisymmetric nature of the wave functions - Slater determinants - approximate wave function of many electron atoms - Born Oppenheiner 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	11 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 Orthoganality theorem and its consequences - Construction of character table for C_{2v} and C_{3v} point groups.

Unit:5	APPLICATIONS OF GROUP THEORY	11 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 Final Examination)	2 hours

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	75 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	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	Inorganic Spectroscopy	L	T	P	C
Elective		Elective -IV	4	1	0	4
Pre-requisite		Knowledge in structural behavior of chemical compounds	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. To understand the role of spectroscopic methods in inorganic chemistry.
2. To acquire basic knowledge about the application of spectral methods in structural elucidation of inorganic compounds.
3. To get an insight on the use of several spectroscopic and analytical techniques for structural investigation of few metalloproteins.

Expected Course Outcomes:

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

1	Student will know complete knowledge about the basics of Inorganic spectroscopy and its application to the structure determination of inorganic compounds.	K3
2	Student can able to solve the problems related to inorganic spectroscopy.	K5
3	Particularly students will learn about the basics and application of IR, Raman, ORD, CD, EPR, NMR, NQR, Mossbauer spectroscopy, Photoelectron spectroscopy and X-ray absorption spectroscopy.	K4
4	Student will acquire deep knowledge about Spectroscopy	K5

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

Unit:1	IR, Raman, ORD & 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 Resonance Spectroscopy	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.

Unit:3	Inorganic NMR, NQR Spectroscopy	12 hours

^{31}P ,^{19}F NMR spectrum of HPX_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. Applications NMR 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**	**11 hours**

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, SnX_5Y (X & Y = F^-, Cl^-, Br^-, I^-) Tin halides - Spin Crossover, Molecular magnetism - Bioinorganic Compounds.

Unit:5	**Photoelectron Spectroscopy & X-ray Absorption Spectroscopy**	**11 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 & EXAFS analysis) – Structure of Metal clusters.

Unit:6	**Mass Spectrometry of Inorganic Compounds (Not for final examination)**	**2 hours**

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	**75 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

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

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

Course code	CHMA2EB	Energy, Diary and Drug Chemistry	L	T	P	C
Elective		Elective-V	4	1	-	4
Pre-requisite		Background knowledge of Bio chemistry with an interest in drug discovery	Syllabus Version		2021-2022	

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-green house effect-earth's energy balance-vibrating molecules and the green house effect-molecular response to radiation-methane and other green house 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-photovolataics-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.

Unit:3	DRUGS CHEMISTRY:	12-- hours

Antibacterial Drugs-Sulpha drugs, (ii) Antibiotics-Sulphanilides-Properties of Sulphanilamides, Mechanism of Action of Sulpha drugs, Sulphanilamide, 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 chickun-guinea-Chikungunya, Causes; Virus; mosquito; Emergent in drug discovery- Comparative studies with malaria.

Unit:4	**DAIRY CHEMISTRY**	**11-- 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.

Unit:5	**AGRICULTURAL CHEMISTRY:**	**11-- hours**

Soil Chemistry-Introduction; Soil classification & 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 final examination)**	**2 hours**

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. M.V.Kaveri / Dr.T.Suresh**	

Mapping with Programme outcomes

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	ARTIFICIAL INTELLIGENCE	L	T	P	C
Elective		Elective-VI	4	1	-	4
Pre-requisite		Design intelligent agents to solve real world problems	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. to introduce Artificial Intelligence & machine learning
2. to facilitate students to learn & 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 & 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

Unit:1	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

Unit:2	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.

Unit:3	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.

Unit:5	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	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	INORGANIC PRACTICALS	L	T	P	C
Practical			0	0	6	4
Pre-requisite		Basic properties of Inorganic salts	Syllabus Version		2021-2022	

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

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

Unit:1 **Qualitative analysis**: **14 hours**

Qualitative analysis employing semi-micro methods and spot tests of mixtures of common cations and ions of the following less familiar elements.
Tungsten, selenium, molybdenum, cerium, thorium, zirconium, vanadium, uranium and lithium.(minimum 5)

Unit:2 **Colorimetry:** **15 hours**

Colorimetric estimations of copper, nickel, iron and chromium using photoelectric colorimeter.

Unit:3 **Titrimetry:** **16 hours**

Complexometric titrations involving estimations of calcium, magnesium, nickel, zinc and hardness of water.

Unit:4 **Preparation of inorganic complexes**: **14 hours**

About six preparations involving different techniques selected from the following.

(i) Nickel ammonium sulphate
(ii) Tris(thiourea)copper(I) chloride
(iii) Potassium tris(oxalato)ferrate
(iv) Hexamminecobalt(III) chloride
(v) Ammonium hexachloro stannate(IV)
(vi) Tetrammine copper(II) sulphate
(vii) Chloropentamminechromium(III)nitrate
(viii) Hydroxyl amine hydrochloride
(ix) Aquapentamminechromium(III)chloride

Total Lecture hours **75 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. M.V.Kaveri	

Mapping with Programme outcomes

PO	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; H-High;

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		2021-2022	

Course Objectives:

The main objectives of this course are to:

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, disfectants 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

COs	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

Third Semester

Course code	CHMA33A	Organic Chemistry –III	L	T	P	C
Core		Organic spectroscopy & photochemistry	4	1	-	4
Pre-requisite		Basic idea on Mechanism of photo chemical reactions & structure of molecules	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. To understand the basic principles of Mass and NMR spectroscopy and their application in organicmolecules
2. To know the basic principles of photochemistry of alkene and ketone in aromatic systems
3. To acquire the knowledge about pericyclic reaction and their stereochemistry involved in the organic molecules.

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. To keep in mind the basic principles involving in photochemistry and pericyclic reactions	K2
2	To understand the concept of Mass and NMR spectroscopies involved in organic molecules and then know about the photochemistry and Pericycliclic reactions mainly play in organic molecules.	K4
3	To apply the concept of Mass and NMR spectroscopy to find out the known and unknown organic molecules. To apply the basic knowledge of photochemistry and pericyclic reactions into the organic molecules tofind out the exact stereochemistry of the reaction systems.	K5
4	To analyze the organic reaction problems by using the Mass and NMR such is frequently asking in competitive examinations. To investigate the organic chemistry problems by using photochemistry and pericyclic reactions in thecompetitive examinations like CSIR-UGC-NET and GATE.	K3

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

Unit:1	Mass spectrometry:	13-- hours

Presentation and analysis of spectra - determination of molecular formula - nitrogen rule - isotopic abundance analysis - metastable ions and peaks - the molecular ion peak. Fragmentation process - symbolism (scission only) - even and odd electron ions - scission with rearrangement - retro Diels-Alder rearrangement - McLafferty rearrangement - double band and (or) ring equivalents implied from a formula.

Fragmentation associated with functional groups - aliphatic compounds - aldehydes - ketones - carboxylic compounds - esters - amides - alcohols - thiols - amines - ethers - sulphides and halides - aromatic compounds - eliminations due to ortho group.

Unit:2	Nuclear Magnetic Resonance Spectroscopy:	13-- 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).

Applications of organic spectroscopy: Structure determination of organic compounds by using

UV-Vis, IR, ^{1}H &^{13}C-NMR and Mass spectroscopic techniques (simple molecules only – restricted to 12 carbon systems with/without one hetero atom).

Unit:3	**Photochemical Excitation and Ketone Photochemistry:**	**13-- 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, Type II, Type III reactions – Photo reduction - oxetane formation – Reactivity of π, π* excited ketones – Photochemistry of α, β- unsaturated ketones - dienone phenol photo rearrangement.

Unit:4	**Photochemistry of Alkenes and Aromatic Compounds:**	**12-- hours**

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 reactions – 1,2 cycloadditions – Photo oxygenation - ene reaction.

Unit:5	**Pericyclic Reactions and their Stereochemistry:**	**12-- hours**

The stereochemistry of electrocyclic reaction - Symmetry properties of molecular orbitals - Symmetry control of electrocyclic reaction - perturbation theory in pericyclic reaction - Woodward Hoffmann rules - orbital correlation diagrams - The Frontier molecular orbital theory - electrocyclic conversion of 1,3 dienes and 1,3,5 trienes.

Sigmatropic reaction – Stereochemistry of Sigmatropic reactions – cycloaddition – classification of cycloaddition reaction – orbital symmetry and cycloaddition – concerted Vs non-concerted cycloaddition - 2+2 and Diels Alder reaction – Reactivity of dienophile and diene– orientation – stereochemistry of Diels Alder reaction.

Unit:6	**Two-Dimensional NMR techniques (not for final examination)**	**2 hours**

Introduction, Theory, Correlation Spectroscopy: ^{1}H-^{1}H COSY: Homonuclear correlated spectroscopy (COSY), Carbon Detected ^{13}C-^{1}H COSY: Heteronuclear Correlation (HETCOR), Proton Detected ^{1}H-^{13}C COSY: Heteronuclear Multiple Quantum Coherence (HMQC), Ipsenol: HETCOR and HMQC, ^{1}H-^{13}C Heteronuclear Multiple Bond Coherence (HMBC), Rotating frame Overhause Effect Spectroscopy (ROESY)

	Total Lecture hours	**65-- 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. Photochemistry in Organic Synthesis – edited by J.D. Coyle – Royal society of Chemistry, 1986

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

4	Photochemistry of heterocyclic compounds – Ole Buchardt – Wiley Interscience 1976.
5	Molecular Photochemistry N.J.Turro and W.A. Benjamin,Inc, NewYork-Amsterdam 1965
6	Molecular reactions and Photochemistry - Charles H.Depuy, Orville.S. Chapman, Prentice – Hall of India Pvt., Ltd. 1988.
7	Frontier orbitals and organic chemical reactions - Ian Fleming John Wiley and sons, 1976.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/104/108/104108124/
2	https://nptel.ac.in/courses/104/106/104106077/
3	https://nptel.ac.in/courses/102/101/102101050/
4	https://nptel.ac.in/courses/104/105/104105038/
5	https://nptel.ac.in/courses/104/105/104105071/
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	CHMA13B	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		2021-2022	

Course Objectives:

The main objectives of this course are to:

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 to:

1	Student will 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	Student will understand the various types of close packing arrangements of different solid structures.	K2
3	Student will learn how to solve the problems in solid state chemistry.	K3
4	Students will get clear idea about the basics of nuclear chemistry and its application in various fields.	K4
5	Student can 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	12 hours

The growth and form of crystals - the crystal systems and Bravais lattices - Miller indices and labelling of planes - symmetry properties - crystallographic point groups and space groups - 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.

Unit:2	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.

Unit:4	Nuclear Chemistry - I	11 hours

Nucleus: nuclear structure - 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**	**11 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.

Unit:6	**Supramolecular Chemistry (Not for final examination)**	**2 hours**

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, *van der waals* 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	W.J. Moore - Physical Chemistry, 4th edition
2	L.V. Azaroff- Introduction of Solids
3	W. E. Addision-Structural Principles in Inorganic Chemistry
4	R. A. Alberty – Physical Chemistry
5	A. K. Das – Fundamental Concepts of Inorganic Chemistry
6	P. Atkins & J. d. Paula – Physical Chemistry
7	S. Glasstone – Sourcebook of Atomic Energy
8	G. Friedlander, J. W. Kennedy, E. S. Macias, J. M. Miller- Nuclear and Radiochemistry 3rd Edition
9	Supramolecular Chemistry by J. W. Steed & J. L. Atwood, 2ndEdn John Wiley, 2009.
10	Crystal Engineering. The Design of Organic Solids by G.R. Desiraju, Elsevier, 1989.

11	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. Dr. B.Murugesapandian and Dr.K.Sundaravel	

Mapping with Programme outcomes

COs	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	Background knowledge on basic chemistry including stoichiometry & Molarity		Syllabus Version	2021-2022		

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 about 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, student will be able to:

1	Get detailed knowledge about the rate of any reaction and various parameters which affects 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	12 hours

Rates of chemical reaction – 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 ion.

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	11 hours

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.

Unit:5	**MACROMOLECULES**	**11 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 & Biodegradable polymers and Bioplastics: (Not for Final Examination)**	**2 hours**

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	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	BIO-ORGANICCHEMISTRY	L	T	P	C
Elective		Elective-VII	4	1	0	4
Pre-requisite		Understanding of some important bio molecules	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. To teach the essential role of organic chemistry inbiology
2. To teach the vital role of vitamins in the biological systems
3. To teach the biosynthetic organic methodologies.
4. To teach the mode of vitamins and energy source in biologicalsystem
5. To teach novel reagents involved in bioorganicreactions
6. 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	Retrosynthetic analysis, protection and deprotection:	12 hours

An introduction to retrosynthesis - synthon – synthetic equivalent – target molecule, functional group interconversion. Retro synthetic analysis and Synthesis of simple organic molecules such as 1,2, 1,3, 1,4 and 1,5 -dicarbonyl compounds both acylic and cyclic. Formation of 3, 4, 5 and 6 membered cyclic compounds. Use of standard reactions, like Grignard reactions, Robinson annulations etc.,

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: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	Bio-Energetics:	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:4	**Novel Reagents in Organic Synthesis:**	**11 hours**
Synthesis and applications of Organolithium, Organomagnesium, Organozinc and Organo copper reagents. Modern synthetic methods: Metal mediated C-C coupling reactions: Mechanism and synthetic applications of Heck, Stille, Suznki, Negishi, Sonogashina, McMurray, Metathesis and Carbonylation reactions.		
Unit:5	**Medicinal Chemistry:**	**11 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- Immunopharmacology and drugdevelopment.		
Unit:6	**Antibiotics:** (Not for Final Examination)	**2 hours**
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 and Ibrahim 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

PO / 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	INDUSTRIAL ORGANIC CHEMISTRY	L	T	P	C
Elective		Elective VIII	4	1	-	4
Pre-requisite		Basic synthetic procedure involved in Chemical Industry	Syllabus Version		2021-2022	

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**:	**11-- 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:**	**11-- 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.		
Unit:6	**Pulp and Paper Technology** (not for final examinations)	**2 hours**
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

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

***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 & analytical skills on computer language	**Syllabus Version**		**2021-2022**	

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 & Visualization - Mean – Median – Mode - Variablity 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.

Unit:5	**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	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	CHMA13P	PHYSICAL CHEMISTRY PRACTICALS	L	T	P	C
PRACTICALS			0	0	6	4
Pre-requisite		Knowledge on phase transformations & titrimetry	Syllabus Version		2021-2022	

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 instruments.	K3
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. — **6 hours**

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. S.N. Karthick

Mapping with Programme outcomes

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

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

Course code	GS	Supportive III	L	T	P	C
Supportive		CHEMISTRY OF ENVIRONMENT	2	0	0	2
Pre-requisite		Basic idea about agriculture & dairy products	Syllabus Version		2021-2022	

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.

Unit:3	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

Fourth Semester

Course code	CHMA43A	Organic Chemistry –IV	L	T	P	C
Core	Alkaloids, Steroids, Functional group transformations, Reagents in Organic Synthesis and Named reactions:		4	1	-	4
Pre-requisite	Basic knowledge on chemical compounds present in the natural products		Syllabus Version	2021-2022		

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 the 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 about the 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 covert the one functional group into other 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	Named reactions:	13 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:	13 hours

Structural elucidation and biosynthesis of dictamnine - chinconine - morphine - reserpine - aeronycine - cocaine - lysergic acid and nicotine.

Unit:3	Steroids:	13 hours

Structural elucidation and spectrum of cholesterol - erogosterol - vitamin-D - equilenin - estrone - progesterone, Stigmasterol, Steroid hormones-androsterone, testosterone, Oesterol, Oestradiol, biosynthesis of steroids – Structure - 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, $LiAlH_4$, Ozone, OsO_4, DCC, 1,3-Dithiane, LTA, DIBAL-H, 9-BBN, Raney Nickel, PPA, CH_2N_2, Tri-n-butyl tin hydride, *n*-Butyl lithium, NBS, DDQ, DBU (Diaza bicyclo-undecane), SeO_2, Tri methyl silyl iodide, Gilman reagent, LDA (lithium diisopropyl amide).		
Unit:6	**Anthocyanins: (Not for Final Examination)**	**2 hours**
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	**75 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

PO / CO	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		Basic facts on metalloorganic chemistry	Syllabus Version	2021-2022		

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

Unit:1 **12-- hours**

Definition of organometallic compound - 18 electron rule - effective atomic number 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 **12-- hours**

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 **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

Unit:4		**11-- 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.

Unit:5		**11-- hours**

Organometallic compounds in homogeneous catalytic reactions - coordinative unsaturation - acid-base behaviour 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 - fluxional molecules.

Unit:6	**(Not for final examination)**	**2 hours**

The Nobel Prize in Chemistry 2001- Assymetric synthesis – Assymetric oxidadion-Assymetric 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.

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 - Priciples 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	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		Core	4	1	0	4
Pre-requisite		Basic concepts of Thermodynamics principles& its properties	Syllabus Version		2021-2022	

Course Objectives:

The main objectives of this course are to:

1. To present the laws of classical and statistical thermodynamics.
2. To learn various co-efficient involved in thermodynamics.
3. To develop a vast knowledge in the interpretation of various physical quantities involved in thermodynamics.

Expected Course Outcomes:

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

1	Understand the concepts of classical and statistical thermodynamics.	K4
2	Comprehend the quantum statistics and partition function.	K2
3	Analyze the variation of fugacity, heat capacities and various quantum statistics in determination of probability.	K3
4	Apply third law of thermodynamics.	K4

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

Unit:1	THERMODYNAMICS AND NON-IDEAL SYSTEMS	12 hours

Chemical potential and the definition of fugacity – Determination of fugacity of gases by graphical method and from equations of state – Variation of fugacity with temperature – Fugacity and the standard state for non-ideal gases – Fugacity (or activity) coefficient – Fugacity and mixtures of non-ideal gases, chemical equilibrium involving non-ideal gases.

Definition of activity. Activity coefficient. Temperature coefficient of activity. Standard states – Application of activity concept to solutions – The rational and practical approaches – Measurement of solvent activity from colligative properties – Determination of activity of solute – Use of activities in the formation of reaction potentials.

Unit:2	THIRD LAW OF THERMODYNAMICS	12 hours

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

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

Unit:3	STATISTICAL THERMODYNAMICS - I	12 hours

Maxwell-Boltzmann statistics – Thermodynamic probability – Thermodynamic probabilities of system in equilibrium – Boltzmann expression for entropy – Sterling's approximation – State of maximum thermodynamic probability – Legrangian 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	11 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:5	**STATISTICAL THERMODYNAMICS - III**	**11 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.

Unit:6	**Irreversible thermodynamics: (Not for Final Examination)**	**2 hours**

Scope of irreversible thermodynamics - Thermodynamic criteria for non-equilibrium states - Phenomenological laws- Linear laws - Gibbs equation - Onsager's reciprocal relations - Entropy production - specific examples of entropy production - Non-equilibrium stationary states - Prigogine's principle of maximum entropy production - Coupled phenomena - Applications.

	Total Lecture hours	**75 hours**

Text Book(s)

1. M.C.Gupta – Statistical Thermodynamics, New Age International, 2007

2. Kalidas, C. & Sangaranarayanan, M.V. Non-Equilibrium Thermodynamics: Principles & Applications, Macmillan India Ltd. (2002).

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. Turcottee – Statistical Thermodynamics, 2nd Ed., 1973.
4	G.W. Castellan - Physical Chemistry, 1983.

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	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	Analytical Chemistry	L	T	P	C
Elective			4	1	0	4
Pre-requisite		Fundamentals about the analytical techniques	Syllabus Version		2021-2022	

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-common ion 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.

Unit:2	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.

Unit:4	Electrochemical Methods of Analysis	11 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**	**11 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 and Computational techniques in Chemistry (Not for Final Examination)**	**2 hours**
a) Sensors- Introduction, Principle, Instrumentation - Calibration, related networks and application, analog and digital sensor instruments, sensors and transducers, smart sensors, wireless and Autonomous sensors, Supporting softwares, Examples and recent Applications. b) 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

PO / CO	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

Annexure

M. Sc. CHEMISTRY

Syllabus

(With effect from 2021-22)

Program Code: 116

DEPARTMENT OF CHEMISTRY
Bharathiar University
(A State University, Accredited with "A" Grade by NAAC and
13th 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.