Integral University, Lucknow
Department of Chemistry

Study and Evaluation Scheme

Program: M.Sc. Chemistry **Semester: First**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA UE	CA TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
THEORIES																				
1.	CH401	Physical Chemistry	Foundation Course	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓		✓		
2.	CH402	Inorganic Chemistry	Foundation Course	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓				
3.	CH403	Organic Chemistry	Foundation Course	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
4.	CH404	Environmental Chemistry	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓	✓	
5.	CH405	Modern Analytical Techniques	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓				
6.	CH419	Chemistry Lab Practicals-I	Core	00	00	08	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓		✓
			Total	**15**	**05**	**08**	**240**	**120**	**360**	**240**	**600**	**24**	**24**							

Semester: Second

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA UE	CA TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
THEORIES																				
1.	CH408	MIMA & Computational Techniques	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		✓
2.	CH409	Chemistry of Natural Products	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
3.	CH411	Pharmaceutical Chemistry	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
4.	CH420	Surface Chemistry and Electrochemistry	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓		✓		
5.	CH421	Coordination and Organometallic Chemistry of Transition Elements	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓					
6.	CH422	Chemistry Lab Practicals-II	Core	00	00	08	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓		✓
			Total	**15**	**05**	**08**	**240**	**120**	**360**	**240**	**600**	**24**	**24**							

L= Lecture, **T**= Tutorial, P = Practical, **CA**= Continuous Assessment, **UE**= Unit Exam. **TA**= Teacher's Assessment, **ESE**= End Semester Examination;
Sessional=CT+TA; **Subject Total**= Sessional+ESE;

Integral University, Lucknow
Department of Chemistry

Study and Evaluation Scheme

Program: M.Sc. Chemistry **Semester: Third**

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA UE	CA TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
THEORIES																				
1.	CH501	Polymer Chemistry	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓				✓
2.	CH513	Organic reaction, Reagents & Heterocyclic Chemistry	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓		✓		
3.	CH514	Chemical Kinetics and Chemical Equilibrium	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓		✓		
4.	CH515	Inorganic Reaction Mechanism and catalysis	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
5.	CH516	Quantum Chemistry and Molecular Spectroscopy	Elective	03	01	00	40	20	60	40	100	3:1:0	4	✓		✓		✓		
	CH506	Bioinorganic & Supra molecular Chemistry												✓	✓	✓				
6.	CH517	Industrial Chemistry Practicals-3	Core	00	00	08	40	20	60	40	100	0:0:4	4	✓	✓	✓		✓		
		Total		**15**	**05**	**08**	**240**	**120**	**360**	**240**	**600**	**24**	**24**							

Semester: Fourth

S. No.	Course code	Course Title	Type of Paper	Period Per hr/week/sem			Evaluation Scheme				Sub. Tot.	Credit	Total Credits	Attributes						
				L	T	P	CA UE	CA TA	Total	ESE				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics
THEORIES																				
1.	CH518	Molecular Spectroscopy and Spectral Techniques	Core	03	01	00	40	20	60	40	100	3:1:0	4	✓					✓	✓
2.	CH509	Green Chemistry	Elective	03	01	00	40	20	60	40	100	3:1:0	4	✓	✓	✓		✓		
3.	CH519	Computational Methods in Chemistry												✓		✓		✓	✓	
4.	CH520	Seminar	Core	00	00	04	00	00	00	100	100	0:0:2	2			✓				✓
5.	CH521	* Project Training & Evaluation	Core	00	00	00	00	00	00	300	300	10	10	✓	✓	✓		✓	✓	✓
		Total		**06**	**02**	**04**	**80**	**40**	**120**	**480**	**600**	**20**	**20**							

L= Lecture, **T**= Tutorial, P = Practical, **CA**= Continuous Assessment, **UE**= Unit Exam. **TA**= Teacher's Assessment, **ESE**= End Semester Examination;

Sessional=CT+TA; **Subject Total**= Sessional+ESE;

***The Evaluation scheme for the Project Training:**

Course Title	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Project Training & Evaluation	CH521	200	50	50	300

SYLLABI

SEMESTER – I

1. Name of the Department: Chemistry						
2. Course Name	**PHYSICAL CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH401**			3	1	0
4. Type of Course (use tick mark)				**Core ()**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and fundamental knowledge of physical chemistry. It is applied in almost all the fields starting from Chemistry to biology, information technology as well as the engineering. After the successfully completion of the course, the students are provided a sound foundation to take up Ph.D. course in the future.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would analyze the idealized version of a gas, a perfect gas and shows how its equation of states may be assembled experimentally.
CO2	Students would able to develop the concept of conservation of energy; assess the energy changes during physical and chemical process.
CO3	Students would differentiate between spontaneous and non-spontaneous process and understand how Gibbs free energy is related to maximum non-expansion work.
CO4	Students would explore the rate of chemical reactions and analyzed how rate of a chemical reaction is varying with change of concentration, pressure and temperature.
CO5	Students would develop the concept of photochemistry and get inside of Lambert-Beer Law, Grothus – Drapper law, Stark – Einstein law, quantum Efficiency and its determination.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Properties of Gases**

The states of gases, gases laws and deviation from ideal behavior, Vander Waals equation of state; Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and vander Waals constants, the law of corresponding states, reduced equation ofstate. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, means free path and collision diameter.

Unit-2	**Number of lectures =08**	**Title of the unit: Classical Thermodynamics**

System & surroundings, intensive and extensive properties, State and path functions and their differentials, Thermodynamic processes, concept of heat and work. First Law of Thermodynamics; Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure, Joule's law – Joule-Thomson coefficient and inversion temperature. Second Law of Thermodynamics: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, clausius inequality, entropy as a criteria of spontaneity and equilibrium, Equilibrium change in ideal gases and mixing of gases, Maxwell's relations.

Unit-3	**Number of lectures = 08**	**Title of the unit: Entropy and Free energy**

Gibbs function (G) and Helmhotz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropychange,VariationofGandAwithP,VandT.Nernstheattheorem,statementandconceptofresidualentropy.ChemicalPotentialandpartialm olarproperties: Gibbs-Duhem equation, concept of fugacity and its determination.

Unit-4	**Number of lectures = 08**	**Title of the unit: Chemical Kinetics**

Rate of a reaction, factors influencing the rate of a reaction; mathematical characteristics of simple chemical reactions – zero order, first order, second order, pseudo order,halflifeandmeanlife,Determinationoftheorderofreaction–differentialmethod,methodofintegration,methodofhalflifeperiodandisolationmethod. Radioactive decayas a first order phenomenon, Theories of chemical kinetics: effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.

Unit-5	**Number of lectures = 08**	**Title of the unit: Photochemistry**

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grothus – Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, Lambert-Beer Law: quantum Efficiency and its determination, Qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), photosensitized reactions – energy transfer processes (simple examples), Kinetics of Photo chemical reaction. (Hydrogen-Bromine, Hydrogen-Chlorine, Decomposition of Hydrogen Iodide and kinetics of Dimerization of Anthracene).

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students would analyze the idealized version of a gas, a perfect gas and shows how its equation of states may be assembled experimentally.	**3**	**2**	**2**		**1**	**3**	**3**	**3**
CO2	Students would able to develop the concept of conservation of energy; assess the energy changes during physical and chemical process.	**3**	**2**	**2**		**1**	**2**	**2**	**2**
CO3	Students would differentiate between spontaneous and non-spontaneous process and understand how Gibbs free energy is related to maximum non-expansion work.	**3**	**2**	**3**		**1**	**3**	**2**	**3**
CO4	Students would explore the rate of chemical reactions and analyzed how rate of a chemical reaction is varying with change of concentration, pressure and temperature.	**3**	**2**	**3**		**1**	**3**	**3**	**2**
CO5	Students would develop the concept of photochemistry and get inside of Lambert-Beer Law, Grothus – Drapper law, Stark – Einstein law, quantum Efficiency and its determination.	**3**	**2**	**1**		**1**	**3**	**2**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. http://home.iitk.ac.in/~gtm/thermodynamics/ui/TOC.htm
2. https://nptel.ac.in/courses/115103113/
3. https://nptel.ac.in/content/storage2/courses/122101001/downloads/lec-27.pdf
4. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering%20Chemistry%201/TOC-mainM6.htm
5. https://www.youtube.com/watch?v=SgTuWj9Tj80

13. Books recommended:

1. Physical Chemistry, P.W. Atkins,ELBS
2. Thermodynamics – J. Rajaram and J.C. Kuriacose – EducationalPublishers.
3. Quantum Chemistry – Eyring, Walter,Kinball
4. Statistical Physics (Part I) (Course of Theoretical Physics Vol. 5) – L.D. London. & E.M. Lefshitz Perganion Zpress,London.
5. Principles of Physical Chemistry by Puri, Sharma andPathan.

1. Name of the Department: Chemistry						
2. Course Name	**INORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH402**			3	1	0
4. Type of Course (use tick mark)				**Core ()**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The purpose of this course is to develop the deep understanding of general characteristic properties of transition elements, nomenclature and isomerism in coordination compounds, organometallic chemistry of transition elements, bioinorganic chemistry and process in human and to gain the knowledge of basics of instrumental spectroscopic techniques.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to understand the approaches to the development of d block fundamental with CFT/VBT/MOT and its widespread applications.
CO2	Students will have a firm foundation in the IUPAC nomenclatures of the complexes and understand technical literature related to the discipline.
CO3	Students will be able to know about the key concepts of inorganic and organometallic chemistry including those related to synthesis, reaction chemistry, and structure and bonding.
CO4	Students will be able to understand the metal component in protein structure and molecular modeling, including the use of the computer program. Transport mechanisms across cell membranes.
CO5	Students will be able to understand the basic and advanced instrumental techniques used in inorganic synthesis including spectroscopic and analytical techniques for identification and characterization of complex molecules.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Coordination Compounds**

General characteristic properties of transition elements, Werner's theory, Effective atomic number, Shapes of d orbitals. Bonding in transition metal complexes; Valence bond theory, Crystal field theory; Octahedral complexes, effects of crystal field splitting, tetrahedral distortion of octahedral complexes (Jahn-Teller Distortion), Square planar arrangements, tetrahedral complexes, chelates, magnetism, Molecular orbital theory.

Unit-2	**Number of lectures =08**	**Title of the unit: Nomenclature And Isomerism In Coordination Compounds**

Nomenclature of co-ordination compounds, isomerism in coordination compounds; Polymerization, Ionization, Hydrate, Linkage, Coordination, Coordi nation position isomerism. Stereoisomerism; Geometrical and optical isomerism. Metal carbonyls, metal clusters and sandwich compounds.

Unit-3	**Number of lectures = 08**	**Title of the unit: Organometallic Chemistry Of Transition Elements**

Ligand hapticity, electron count for different types of organometallic compounds, 18 and 16 electron rule exceptions, synthesis, structure and bonding, organometallic reagents in organic synthesis and in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation and polymerisation).

Unit-4	**Number of lectures = 08**	**Title of the unit: Bioinorganic Chemistry**

Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.

Unit-5	**Number of lectures = 08**	**Title of the unit: Characterization Of Inorganic Compounds**

Characterization of inorganic compounds by IR, Raman, NMR, EPR, Mossbauer, UV-Vis, NQR, MS, electron spectroscopy and microscopic techniques..

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students will be able to understand the approaches to the development of d block fundamental with CFT/VBT/MOT and its wide spread applications.	**3**	**1**	**1**		**2**	**1**		
CO2	Students will have a firm foundation in the IUPAC nomenclatures of the complexes and understand technical literature related to the discipline.	**3**	**2**	**1**		**2**	**2**		
CO3	Students will be able to know about the key concepts of inorganic and organometallic chemistry including those related to synthesis, reaction chemistry, and structure and bonding.	**3**	**2**	**2**		**2**	**2**		
CO4	Students will be able to understand the metal component in protein structure and molecular modeling, including the use of the computer program and transport mechanisms across cell membranes.	**3**	**2**	**2**		**2**	**2**		
CO5	Students will be able to understand the basic and advanced instrumental techniques used in inorganic synthesis including spectroscopic and analytical techniques for identification and characterization of complex molecules.	**3**	**2**	**1**		**2**	**2**		

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://freevideolectures.com/course/3412/co-ordination-chemistry
2. http://wwwchem.uwimona.edu.jm/courses/IC10Kiso.pdf
3. https://nptel.ac.in/courses/104101091/
4. https://nptel.ac.in/courses/104104109/
5. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104106074/lec24.pdf

13. Books recommended:

1. F. Albert Cotton, Geoffery Wilkinson, Carlos A. Murillo and Manfred Bochmann. Advanced Inorganic chemistry, Sixth edition, Wiley India Pvt.Ltd.
2. J. D. Lee, Concise Inorganic Chemistry, Fifth edition, Wiley India Pvt.Ltd.
3. J H Huheey, Inorganic Chemisry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York(1972).

1. Name of the Department: Chemistry						
2. Course Name	**ORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH403**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: Students will be able to gain knowledge of Generation, stability and reactivity of intermediates, Name reactions. pericyclic reactions, concerted pi electron shift and minimize environmental pollution through without use of solvents concepts of stereochemistry of acyclic & cyclic compounds, stereo chemical properties and their applications.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Analyze and compare reactivity and stability of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes and addition reactions with electrophilic, nucleophilic or radical species
CO2	Comprehension of types of Organic reaction mechanisms involving elimination and substitution reactions with electrophilic, nucleophilic or radical species.
CO3	Able to evaluate different types of Name reactions and its mechanism.
CO4	Know about Pericyclic reactions, types of Pericyclic reactions, stereochemistry, thermal and photochemical cyclisation, Cope and Claisen rearrangement.
CO5	Understand the Principles of stereochemistry, Configurational and conformational isomerism in acyclic and cyclic compounds, stereogenicity, stereoselectivity, enantioselectivity and diastereoselectivity.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Reactive intermediates**

Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes. Organic reaction mechanisms involving addition reactions with electrophilic, nucleophilic or radical species.

Unit-2	**Number of lectures =08**	**Title of the unit: Reaction mechanisms and Name reactions**

Organic reaction mechanisms; involving, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Neighbouring group participation, elimination: E2 vs E1, elimination vs substitution. Aldol condensation, Cannizzaro reaction, Hofmann, Beckmann and Fries rearrangements, Reimer-Tiemann reaction.

Unit-3	**Number of lectures = 08**	**Title of the unit: Name reactions**

Reformatsky and Grignard reactions, Michael addition, Friedel-Crafts reaction, Witting reaction, Oppenaur oxidation, Clemmensen reduction, Wolff-Kishner reduction, Meerwein-Ponndorf Verley reduction and birch reduction, hydroboration-oxidation, oxymercuration and deoxymercuration.

Unit-4	**Number of lectures = 08**	**Title of the unit: Pericyclic, Electrocyclic, Cycloaddition reactions and Sigmatropic rearrangements**

Pericyclic reactions: Introduction, π molecular orbital of ethylene and 1,3-butadiene. Electrocyclic reactions: Introduction, stereochemistry for the ring opening and ring closing electrocyclic reactions, thermal and photochemical cyclisation of (4n) and (4n+2) system. Cycloaddition reactions: Introduction, Thermal andphotochemical induced (2+2) and (4+2) cycloaddition reactions. Sigmatropic rearrangements: Introduction, classification, Cope and Claisen rearrangement..

Unit-5	**Number of lectures = 08**	**Title of the unit: Principles of stereochemistry**

Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity and diastereoselectivity.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Analyze and compare reactivity and stability of carbocations, carbanions, free radicals, carbenes, nitrenes and benzynes and addition reactions with electrophilic, nucleophilic or radicalspecies.	**3**	**1**	**2**	**1**		**2**	**2**	**2**
CO2	Comprehension of types of Organic reaction mechanisms involving elimination and substitution reactions with electrophilic, nucleophilic or radicalspecies.	**3**	**1**	**2**	**1**		**2**	**2**	**2**
CO3	Able to evaluate different types of Name reactions and its mechanism.	**3**	**1**	**2**	**1**		**2**	**2**	**2**
CO4	KnowaboutPericyclicreactions,typesofPericyclicreactions,stereochemistry,thermalandphotochemical cyclisation, Cope and Claisen rearrangement.	**3**	**1**	**2**	**1**		**3**	**3**	**2**
CO5	Understand the Principles of stereochemistry, Configurational and conformational isomerism in acyclic and cyclic compounds, stereogenicity, stereoselectivity, enantioselectivity and diastereoselectivity.	**3**	**1**	**2**	**1**		**2**	**2**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/courses/104105104/
2. https://nptel.ac.in/courses/104101005/
3. https://nptel.ac.in/courses/104103023/
4. https://nptel.ac.in/courses/104106077/
5. https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod8.pdf

13. Books recommended:

1. Advanced Organic Chemistry (Reactions, Mechanisms and Structure): Michel B. Smith and Jerry March, 4th Edition, Wiley IntersciencePublication.
2. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Six edition, Pearsonpublication.
3. Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd, and Saibal Kanti Bhattacharjee, Seventh edition, Pearsonpublication.
4. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren, Second edition, OxfordPublication.
5. Organic Chemistry by T.W.Graham Solomons, and Craig B. Fryhle, Ninth edition, WileyPublication.
6. Organic Chemistry by IL Finar, Volume 1 & 2, Sixth edition, PearsonPublication.

1. Name of the Department: Chemistry						
2. Course Name	ENVIRONMENTAL CHEMISTRY			L	T	P
3. Course Code	CH404			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	B.Sc. with Chemistry	6. Frequency (use tick marks)	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		Tutorials = 10		Practical = Nil		

8. COURSE OBJECTIVES: The main objectives of this course is to study various types of pollutants, their sources, effects on living and non living species and related control measures.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluate different types of air pollutants, their harmful effects on living and non living species, their control measures; Study of Global Warming, Green House Effect and Ozone Layer Depletion.
CO2	Analyze the various factors of water quality assessment parameters, water pollutants and their sources and different types of waste water treatment processes.
CO3	Understand the importance of soil composition; Analyze various types of soil pollutants, their control and related standards.
CO4	Evaluate the various types of waste and their toxicity aspects and management.
CO5	Understand the sources of heavy metals and their health hazards

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Air pollutants

CO, CO2, ozone, CFC, & NOx, ozone depletion, global warming, Harmful effects of pollutants on living and non-living species, Analytical methods for monitoring air pollutants, international and national standards.

Unit-2	Number of lectures =08	Title of the unit: Physical, chemical and biological water quality parameters

Physical, chemical and biological water quality parameters; their assessment; Water pollution; water pollutants; toxicity aspects; international and national standards; control; Water sampling techniques; Water treatment processes: aeration, solid purification, nanofiltration, chemical treatments, reverses osmosis, desalination. Waste water treatment processes. Water table maintenance & harvesting methods.

Unit-3	Number of lectures = 08	Title of the unit: Composition of soil

Inorganic and organic components, micro and macronutrients; Soil pollution; Fertilizers, insecticides, pesticides, plastics, toxic metals, dyes, surfactants; toxicity aspects; international and national standards; control.

Unit-4	Number of lectures = 08	Title of the unit: Industrial waste

Toxic aspects, management and disposal; Radioactive, municipal, agricultural and biomedical waste – toxicity hazards. Bhopal gas tragedy, Chernobyl disaster.

Unit-5	Number of lectures = 08	Title of the unit: Heavy metal in the environment

Sources of heavy metals; Poisoning of heavy metals in every bite; Mercury, Copper, Chromium, Cadmium, Cobalt, Lead, Arsenic.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Evaluate different types of air pollutants, their harmful effects on living and non living species, their control measures; Study of Global Warming, Green House Effect and Ozone LayerDepletion.	3	2	3	3	3	3	3	2
CO2	Analyze the various factors of water quality assessment parameters, water pollutants and their sources and different types of waste water treatmentprocesses.	3	2	3	3	3	3	3	2
CO3	Understand the importance of soil composition; Analyze various types of soil pollutants their control and relatedstandards.	3	1	3	3	3	3	3	3
CO4	Evaluate the various types of waste and their toxicity aspects and management.	3	2	3	3	2	3	3	2
CO5	Understand the sources of heavy metals and their health hazards.	3	2	3	3	3	3	3	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/content/storage2/courses/105102089/air%20pollution%20(Civil)/Module-1/2.htm
2. https://www.youtube.com/watch?v=xw9FPlq0sJ8
3. https://www.youtube.com/watch?v=7kizaNBowrw
4. https://www.youtube.com/watch?v=dnQjYXXX17A
5. https://www.ukessays.com/essays/environmental-sciences/the-issue-of-heavy-metals-contamination-environmental-sciences-essay.php

13. Books recommended:

1. Environmental Chemistry Manahan, Stanley E, 2004, Taylor & FrancisLtd.
2. Basic Concepts of Environmental Chemistry, Desley W. Connell, 1 edition,CRC-Press
3. Environmental Chemistry: A Global Perspective, Gary W. Vanloon Stephen J. Duffy , Oxford Univ Pr(Sd).
4. Introduction To Environmental Chemistry, Reid, Brian J. Blackwell ScienceLtd.
5. Chemistry of the Environment, Thomas G. Spiro, William M. Stigliani, 2nd Edition, Prentice Hallpublication.

1.Name of the Department: Chemistry						
2.Course Name	MODERN ANALYTICAL TECHNIQUES			L	T	P
3.Course Code	CH405			3	1	0
4.Type of Course (use tick mark)				Core(√)	DE( )	FC( )
5.Pre-requisite(if any)	B.Sc. with Chemistry	6.Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	EverySem( )

7.Total Number of Lectures, Tutorials, Practicals

Lectures=30	Tutorials=10	Practical=Nil

8. COURSE OBJECTIVES: The course aims at providing knowledge of principles and instrumentations of UV, IR, NMR, Atomic absorption spectroscopy and Mass spectrometry. Make the students able to interpret and assign spectroscopic data as a tool for structural elucidation.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Explain the effect of conjugation, solvent polarity and non-bonding electrons on a UV/Vis absorption spectrum. Evaluate the utility of UV/Vis spectroscopy as a qualitative and quantitative method. Application of correct Woodward-Fieser rules to calculate wavelength of maximum absorption of organic compounds.
CO2	Comprehension of factors affecting vibrational, frequencies, vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, acids, anhydrides, interpret and assign IR spectroscopic data as a tool for structural elucidation.
CO3	Argue how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed. Identify the number of proton and carbon NMR signals expected from a compound given its structure, splitting pattern in the proton NMR spectrum of a compound given its structure, to assign peaks with the aid of a chart of chemical shifts from 1H and 13C NMR in an NMR spectrum to specific protons and carbons in a compound.
CO4	Become familiar with the mass spectrometric technique, different types of ionization techniques and sketch components of a mass spectrometer and functions of each. Application of a mass spectrometric technique, distinguish fragmentation methods. Interpretation of mass spectra
CO5	Comprehension of principle, instrumentation, interferences and Sample preparation, Applications of AAS

10.Unitwisedetailedcontent

Unit-1	Number of lectures=08	Title of the unit: UV Spectroscopy

Wave-like propagation of light, absorption of electromagnetic radiation by organic molecules allowed and forbidden transitions, instrumentation, effect of solvents on electronic transitions, formation and designation of absorption bands, conjugated systems and transition energies, unsaturated carbonyl compounds, dienes and conjugated polyenes, Woodward – Fieser rules

Unit-2	Number of lectures= 08	Title of the unit: IR Spectroscopy

Introduction, absorption in the infrared region, theory of infrared spectroscopy, instrumentation, molecular vibrations, calculation of vibrational frequencies, factors affecting vibrational frequencies, characteristic absorptions in common classes of compounds, fingerprint region, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ether, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, acids, anhydrides), applications of infrared spectroscopy.

Unit-3	Number of lectures=08	Title of the unit: NMR Spectroscopy

Introduction, theory of NMR spectroscopy, Instrumentation, chemical shift, equivalent and nonequivalent protons, s pin-spin splitting, vicinal coupling and stereostructure, proton exchange reactions, nuclear overhauser effect (NOE), shift reagents, principle of C-13 NMR spectroscopy, Relaxation and dynamic processes - Spin lattice relaxation (T1) and Spin - spin relaxation (T2) measurements. Interpretation of NMR spectra of some representative compounds.

Unit-4	Number of lectures=08	Title of the unit: Mass Spectrometry

Introduction, basic theory, instrumentation, important useful terms in mass spectrometry, various modes of ionization (EI, CI, FD and FAB) and their applications, fragmentation patterns of various functional groups (alkanes, alkenes, alkynes, alcohols, ether, phenols, amines, ketones, aldehydes, esters, acids and anhydrides), molecular ion peak, metastable peak, Mclafferty rearrangements, Nitrogen rule.

Unit-5	Number of lectures=08	Title of the unit: Atomic Absorption

Spectrophotometry: Introduction, Principle, Instrumentation, Interferences- Spectral, Ionization, Physical and Refractory compound formation, Sample preparation, Internal standard and standard addition calibration and applications of AAS.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Explain the effect of conjugation, solvent polarity and non-bonding electrons on a UV/Vis absorption spectrum. Evaluate the utility of UV/Vis spectroscopy as a qualitative and quantitative method. Application of correct Woodward-Fieser rules to calculate wavelength of maximum absorption of organic compounds.	3	2	1	1		3	2	2
CO2	Comprehension of factors affecting vibrational, frequencies, vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, acids, anhydrides, interpret and assign IR spectroscopic data as a tool for structural elucidation.	3	2	1	1		3	2	2
CO3	Argue how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed. Identify the number of proton and carbon NMR signals expected from a compound given its structure, splitting pattern in the proton NMR spectrum of a compound given its structure, to assign peaks with the aid of a chart of chemical shifts from 1H and 13C NMR in an NMR spectrum to specific protons and carbons in a compound.	3	2	1	1		3	2	2
CO4	Become familiar with the mass spectrometric technique, different types of ionization techniques and sketch components of a mass spectrometer and functions of each. Application of a mass spectrometric technique, distinguish fragmentation methods. Interpretation of mass spectra	3	2	1	1		3	2	2
CO5	Comprehension of principle, instrumentation, interferences and Sample preparation, Applications of AAS	3	2	2	2	1	3	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12.Brief description of self-learning /E-learning component

1. https://www.youtube.com/watch?v=tbUx-RaZS7M
2. https://nptel.ac.in/courses/103108139/
3. https://nptel.ac.in/courses/104108078/
4. https://nptel.ac.in/courses/102101050/
5. https://www.youtube.com/watch?v=xOKoVOMKHN8

13. Books recommended:

1. Introduction to spectroscopy: Pavia, Lampman & Kriz, 3rd Ed, Books/cole.
2. Spectroscopic methods in organic chemistry: H. Williams and Ian fleminig, V EditionTata Mc Grawhills
3. Organic spectroscopy: William Kemp, 3rd Edition, Palgrave publications.
4. Fundamentals of Analytical chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, 7th edition, Harcourt college publications.

1. Name of the Department: Chemistry						
2. Course Name	**CHEMISTRY LAB PRACTICAL-1**			**L**	**T**	**P**
3. Course Code	**CH419**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. COURSE OBJECTIVES: To develop practical and technical skills for better understanding of theory. To develop transferrable skills and enhancing communication skills of students.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Perform accurate and precise analysis in the field of industrial chemistry.
CO2	Able to examine water quality parameters (DO, COD, BOD and TDS) and argue about water quality.
CO3	Explain the principles of chromatographic techniques, UV spectroscopy and viscosity measurements.
CO4	Organize the records of all performed experiments in the manner which is required in laboratory.
CO5	Analyze the importance of personal safety and care of equipments and chemicals.

10. List of experiments

1. To determine the percentage composition of the given mixture consisting of two liquids A and B by viscositymethod.
2. To determine the relative surface tension of a liquid byStalagnometer.
3. To determine the molecular weight of non-volatile solute cryscopically using water assolvent.
4. Selective extraction of iron metal cation from mixture of iron and magnesium for determination of their respectiveconcentration.
5. Paper chromatography separation of metalion.
6. Determination of copper and nickel in thegivensample.
7. Separation of amino acid by thinlayerchromatography.
8. Separation of mixture of carbohydrate by thin layerchromatography.
9. Separation of mixture of dyes by columnchromatography.
10. Oxime and 2, 4 dinitrophenylhydrazone ofaldehyde/ketone.
11. Determination of Dissolved Oxygen (D.O.) in the given watersample.
12. Determination of Conductivity of the watersample.
13. Determination of Total Dissolved Solid (T.D.S.) in the given watersample.
14. Determination of concentration of KMnO4 by UV-VisibleSpectrophotometer.
15. Determination of iron content in the given water sample by UV-VisibleSpectrophotometer.
16. Determination of Chlorophyll in olive oil by UV-Visible Spectroscopy.
17. Separation of plant pigment from green leaves by columnchromatography.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Perform accurate and precise analysis in the field of industrial chemistry.	**3**	**2**	**2**	**1**	**3**	**3**	**3**	**2**
CO2	Able to examine water quality parameters (DO, COD, BOD and TDS) and argue about water quality	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**
CO3	Explain the principles of chromatographic techniques, UV spectroscopy and viscosity measurements.	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**
CO4	Organize the records of all performed experiments in the manner which is required in laboratory.	**3**	**3**	**2**	**2**	**3**	**1**	**3**	**2**
CO5	Analyze the importance of personal safety and care of equipments and chemicals.	**3**	**1**	**2**	**2**	**3**	**3**	**3**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self- learning / E-learning component

1. https://www.fondriest.com/environmental-measurements/measurements/measuring-water-quality/dissolved-oxygen-sensors-and-methods/
2. http://www.nsec.ac.in/images/bes_Viscosity%20of%20Sugar%20Solution.pdf
3. https://www.youtube.com/watch?v=8wmQ_xWqZbo
4. https://www.youtube.com/watch?v=kXI_Om-2XYk
5. https://www.youtube.com/watch?v=YBeZZwNSeb8
6. https://www.youtube.com/watch?v=WBYop48A4gM
7. https://www.youtube.com/watch?v=V16USbjKZXw

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, PragatiEdition.
2. Practical Organic ChemistryA.I.Vogel.
3. Practical Physical Chemistry : B. Viswanathan and P.S.Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.

SEMESTER-II

1.Name of the Department: Chemistry						
2.Course Name	**MODERN INSTRUMENTAL METHODS OF ANALYSIS AND COMPUTATIONAL TECHNIQUES**			**L**	**T**	**P**
3.Course Code	**CH408**			3	1	0
4.Type of Course (use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (if any)	B.Sc. with Chemistry	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	EverySem( )
7.Total Number of Lectures, Tutorials, Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: This course is designed for postgraduate students of chemistry and industrial chemistry as a broad base introduction to analytical instrumentation techniques for the measurement of different chemical and physical properties of compounds and materials (composition, structure, etc.). After successfully completion of course, the student will able understand the working principal and applications of various modern analytical techniques as well as their operation.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would able to analyze the data by applying different type of statistical methods and would also understand the different between systematic and random errors.
CO2	Students evaluate fundamentals of electrochemistry and recognize the electrochemical processes. They got sound inside of different type of polarographic and voltammetric methods and their applications.
CO3	Students would develop the concept of thermogravimetric analysis, differential analysis and differential scanning calorimetry methods and their applications.
CO4	Students would restate difference between different modes of chromatographic separation; apply knowledge of qualitative and quantitative analysis in various fields of chemical, pharmaceutical industry etc.
CO5	Students would able to illustrate how the computer and software are used in analytical laboratory and got springboard for further study.

10.Unit wise detailed content

Unit-1	**Number of lectures=08**	**Title of the unit: Errors and Evaluation**

Definition of terms mean and median, precision, standard deviation, relative standard deviation, accuracy, absolute error, relative error, types of error in experimental data, determinate (systematic), indeterminate (random) and gross, sources of errors and their effects upon the analytical results, statistical evaluation of data-normal distribution, interval estimation, methods of least squares.

Unit-2	**Number of lectures= 08**	**Title of the unit: Polarographic Techniques and Voltammetry**

Polarography; Theory, Instrumentation and its working; Advantages of using dropping mercury electrode, Derivation of Ilkovic equation, Factors affecting the limiting current, The half wave potential, Criterion of reversibility, Applications of polarography, Square-wave polarography, Differential pulse polarography and cyclic voltammetry showing cyclic voltammetric excitation.

Unit-3	**Number of lectures=08**	**Title of the unit: Thermal Methods**

Thermogravimetric analysis, Instrumentation and Applications, Differential thermal analysis, General principles and applications with special reference to polymers; Differential scanning calorimetry, Theory and different types of thermal scanning calorimetry, Instruments, Power compensated DSC instrument, Heat flux DSC instrument and modulated DSC instrument, DSC data analysis and applications.

Unit-4	**Number of lectures=08**	**Title of the unit: Chromatography**

Chromatographic mechanism, Classification of chromatography, principles, types, techniques of column chromatography and techniques of elution, thin layer chromatography, Gas chromatography, Applications of gel permeation and ion exchange chromatography. Introduction of HPLC, instrumentation, reverse phase HPLC, industrial applications of HPLC.

Unit-5	**Number of lectures=08**	**Title of the unit: Computer application**

Elements of computer system set-up, components of computer system, generation of computer and computer languages, personnel computers, PC-software packages, an introduction, disk operating system and windows, text processing software, introduction to a spreadsheet software, creation of spreadsheet software, creation of spreadsheet applications, range, formulas, function, data base functions in spreadsheets, graphics on spreadsheet, presentation graphics, creating a presentation on a PC, data communications, networking: Lan & Wans, software system, softw are development process, file design & report design, Data files: types/organization, master & transaction file, relevance of database management systems and integration of applications, basic of data processing, flow charting, input-process- output analysis, report generation and label generation.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students would able to analyze the data by applying different type of statistical methods and would also understand the different between systematic and random errors.	**3**	**1**	**1**		**2**	**3**	**2**	**3**
CO2	Students evaluate fundamentals of electrochemistry and recognize the electrochemical processes. They got sound inside of different type of polarographic and voltammetric methods and their applications.	**3**	**1**	**1**		**1**	**3**	**2**	**3**
CO3	Students would develop the concept of thermogravimetric analysis, differential analysis and differential scanning calorimetry methods and their applications.	**3**	**1**	**1**		**1**	**3**	**2**	**2**
CO4	Students would restate difference between different modes of chromatographic separation; apply knowledge of qualitative and quantitative analysis in various fields of chemical, pharmaceutical industry etc.	**3**	**2**	**1**		**2**	**3**	**1**	**2**
CO5	Students would able to illustrate how the computer and software are used in analytical laboratory and got springboard for further study.	**3**	**2**	**1**		**3**	**3**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12.Brief description of self-learning /E-learning component

1. https://www.youtube.com/watch?v=HEgl0JyX80U
2. https://www.youtube.com/watch?v=d1vv7ww8xtA
3. https://www.youtube.com/watch?v=NzbDEjI8IKE
4. https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod5.pdf
5. https://www.youtube.com/watch?v=Cu_WeVyOaHI

13. Books recommended:

1. Fundamentals of Analytical chemistry, Douglas A. Skoog, Donald M. West, F.James Holler, 7th edition, Harcourt college publications.
2. Principles and practice of analytical chemistry, F. W. Fifield, D. Kealey, 5th edition, Blackwell publication.
3. Analytical chemistry, Gary D. Christian, 6th edition, Wiley and sons publication.
4. Basic concepts of analytical chemistry, S. M. Kopper, New Age International Publishers.

1. Name of the Department: Chemistry						
2. Course Name	CHEMISTRY OF NATURAL PRODUCTS			L	T	P
3. Course Code	CH409			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	B.Sc. with Chemistry	6. Frequency (use tick marks)	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: Students gain the knowledge of secondary plant metabolites such as terpenoids, alkaloids, carbohydrates, Amino Acid, Peptides & Proteins, steroids, Synthesis and medicinal uses of; caffeine, theophylline, theobromine andPhytopharmaceuticals.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Create the concept of secondary plant metabolites; terpenoids and its general methods of structure determination, isoprene rule; Stereochemistry, constitution and synthesis of Citral and Menthol.
CO2	Evaluate the general method of isolation, structure elucidation of alkaloid, specially based on nitrogen heterocyclic ring (Hofmann's exhaustive methylation, Emde's degradation and Von Braun's method).
CO3	Analyze general reactions, constitution of glucose & fructose; Conformations of monosaccharide's. Stereochemistry and configuration of the nucleus of steroids.
CO4	Know about, classification, general method of preparation, properties and reactions of amino acids, general method of synthesis & determination of structure of polypeptides. Primary, secondary, tertiary & quaternary structure ofproteins.
CO5	Understand the Synthesis and medicinal uses of; caffeine, theophylline, theobromine. Phytopharmaceuticals: Recent development and commercialization of plant derived natural products. Strategies for rapid identi fication of novel therapeutic leads from natural products.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Terpenoids

Introduction, nomenclature, occurrence, general properties, classification, isolation and general methods of structure determination of terpenoids, isoprene rule; Stereochemistry,constitutionandsynthesisofCitralandMenthol.Carotenoids;Introduction,classification,isolationandgeneralmethodofstructuredeterminationof carotenoids.

Unit-2	Number of lectures =08	Title of the unit: Alkaloids

Introduction,nomenclature,classification,isolation,physiologicalaction,occurrenceandgeneralmethodsofstructureelucidationofalkaloid,specia llybasedonnitrogen heterocyclic ring (Hofmann's exhaustive methylation, Emde's degradation and Von Braun's method).

Unit-3	Number of lectures = 08	Title of the unit: Carbohydrates & Steroids

Introduction,classification,generalreactions,constitutionofglucose&fructose;Conformationsofmonosaccharide's.Steroids;Introduc tion,Diel'shydrocarbon, nomenclature, stereochemistry and configuration of the nucleus of steroids.

Unit-4	Number of lectures = 08	Title of the unit: Amino Acid, Peptides & Proteins

Introduction,nomenclature,classification,generalmethodofpreparation,propertiesandreactionsofaminoacids.Introduction,occurrenc e,nomenclature,general method of synthesis & determination of structure of polypeptides. Primary, secondary, tertiary & quaternary structure of proteins.

Unit-5	Number of lectures = 08	Title of the unit: Phytopharmaceuticals

Synthesis and medicinal uses of; caffeine, theophylline, theobromine. Phytopharmaceuticals: Recent development and commercialization of plant derived natural products. Strategies for rapid identification of novel therapeutic leads from natural products.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Create the concept of secondary plant metabolites; terpenoids and its general methods of structure determination, isoprene rule; Stereochemistry, constitution and synthesis of Citral and Menthol.	3	1	2	1		2	2	2
CO2	Evaluate the general method of isolation, structure elucidation of alkaloid, specially based on nitrogen heterocyclic ring (Hofmann's exhaustive methylation, Emde's degradation and Von Braun'smethod).	3	1	2	1		2	2	2
CO3	Analyze general reactions, constitution of glucose & fructose; Conformations of monosaccharides. Stereochemistry and configuration of the nucleus of steroids.	3	1	2	1		2	2	2
CO4	Know about, classification, general method of preparation, properties and reactions of amino acids, general method of synthesis & determination of structure of polypeptides. Primary, secondary, tertiary &quaternary structure of proteins.	3	1	2	1		2	1	2
CO5	Understand the Synthesis and medicinal uses of; caffeine, theophylline, theobromine. Phytopharmaceuticals: Recent development and commercialization of plant derived natural products. Strategies for rapid identification of novel therapeutic leads from natural products.	3	1	2	1		2	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.intechopen.com/books/terpenes-and-terpenoids/introductory-chapter-terpenes-and-terpenoids
2. https://www.intechopen.com/books/alkaloids-their-importance-in-nature-and-human-life/introductory-chapter-alkaloids
3. https://study.com/academy/lesson/steroids-structure-function.html
4. http://chemistry.creighton.edu/~jksoukup/lec5-aminoacidsSTUD.pdf
5. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/127106009/lec4.pdf

13. Books recommended:

1. Natural products: Chemistry and Biological Significance, J.Mann, R.S.Davidson,J.B.Hobbs,d.V. Banthrope and B.Harborne, Longman,Essex.
2. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
3. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta Anda. Marston, Harwood Academic Publishers.
4. Chemistry of natural products, S.V.Bhat, B.A.Nagasampagi, M. Sivakumar.
5. Natural products from plants, Peter B. Kaufman, Leland J. Creke, Sara Warber, James A. Dupe, Harry L. Brielmann ,CRC publication
6. Organic chemistry of natural products, Vol. I and II , Gurdeep Chatwal, Himalya Publishing house.

1. Name of the Department: Chemistry						
2.Course Name	**CORROSION, LUBRICATION AND PAINT TECHNOLOGY**			**L**	**T**	**P**
3.Course Code	**CH410**			3	1	0
4.Type of Course (use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (if any)	B.Sc. with Chemistry	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	EverySem( )
7.Total Number of Lectures,Tutorials,Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: Main objective includes deep understanding of mechanism of corrosion, lubrication and action of lubricants, properties, constituents and formulation of industrial paints, dyes and varnishes.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Explain the theories and mechanisms of corrosion. Describe, identify, analyze, and compare different corrosion types. Formulate industry relevant surface treatment methods for metals and alloys and corrosion protection strategies.
CO2	Comprehension of the fundamentals of lubricants, lubrication and the lubricants operating requirements, relationship with the lubrication requirements, as well as on the lubricants properties. Know how to recommend a lubricant and how to identify the causes of in-service issues and their solutions, defend the selection of an appropriate lubricant for perfect lubrication.
CO3	Describe the ingredients and characteristics of paint. Evaluate the properties (adhesion, hardness, thickness, extent of cure, etc.) of the cured film. Will be familiar with the composition of paints and coatings and modern technologies used in the preparation of paint/coatings formulations.
CO4	Comprehension of properties, constituents and formulations of pigments and dyes, differentiate dyes and pigments, their mechanisms of action and applications.
CO5	Comprehensive understanding of properties, constituents, formulations and uses of varnishes. Develop an appropriate choice of coating material (paint, pigment, dye or varnish) based on the nature of the substrate.

10.Unit wise detailed content

Unit-1	**Number of lectures=08**	**Title of the unit: Corrosion**

Introduction to corrosion, cause of corrosion, Theories of Corrosion, Mechanism of Electrochemical or Wet corrosion, dry corrosion, Factors influencing corrosion; Types of corrosion- Galvanic corrosion, Erosion Corrosion, Crevice corrosion, Pitting corrosion, Intergranular corrosion, Waterline Corrosion, Stress corrosion, Microbiological corrosion, Fatigue Corrosion, Fretting Corrosion; Protection from corrosion: Design and Material selection, Cathodic & Anodic protection, Corrosion inhibitors, Passivity, Galvanizing, Tinning and Electroplating, Pourbiax (P^H potential) diagram

Unit-2	**Number of lectures=08**	**Title of the unit: Lubrication**

Introduction, Friction and wear, Lubricants, Theories of Friction, Lubrication and wear, Mechanism of lubrication- Fluid or Hydrodynamic; lubrication, Boundary and extreme pressure lubrication; Classification of lubricants: Solid, Semisolid, Synthetic lubricants, lubricating oils - vegetable oils, animal oils, mineral oils, blended oils, lubricating emulsion, greases; Properties of lubricating oils, cutting fluids, selection of lubricants.

Unit-3	**Number of lectures=08**	**Title of the unit: Paint Technology**

Introduction to paint, ingredient and classification; Essential concepts of paint formulation, formulation of coating for mas onry, steel work, aircrafts, automobile, distempers, etc., Failure of paint film; Testing and evaluation tests of liquids films, dry films, performance and weathering test, world standard specification for paints and materials.

Unit-4	**Number of lectures=08**	**Title of the unit: Pigments and Dyes**

Introduction to pigments, general and physical properties; Preparation, properties and uses of Black pigment (Carbon black), Yellow pigment (chrome yellow), Red pigment (Red lead), Green pigment (Chrome green), White pigment (ZnO), Blue pigment (Ultramarine blue); Properties of Coating, solvent plasticizers Dyes: Introduction, Classification, Methods of dyeing, Basic operations in dyeing, Study of Phenolphthalein, Methyl orange and Crystal violet. Difference between pigment and dye.

Unit-5	**Number of lectures=08**	**Title of the unit: Varnishes**

Introduction to varnishes, physical properties of varnishes; Constituents of varnishes, classification and formulation of industrial varnishes; Characteristics of good varnish; Applications of varnish.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Explain the theories and mechanisms of corrosion. Describe, identify, analyze, and compare different corrosion types. Formulate industry relevant surface treatment methods for metals and alloys and corrosion protection strategies.	**3**	**2**	**2**	**2**		**2**	**2**	**2**
CO2	Comprehension of the fundamentals of lubricants, lubrication and the lubricants operating requirements, relationship with the lubrication requirements, as well as on the lubricants properties. Know how to recommend a lubricant and how to identify the causes of in-service issues and their solutions, defend the selection of an appropriate lubricant for perfect lubrication.	**3**	**2**	**2**	**2**		**2**	**1**	**2**
CO3	Describe the ingredients and characteristics of paint. Evaluate the properties (adhesion, hardness, thickness, extent of cure, etc.) of the cured film. Will be familiar with the composition of paints and coatings and modern technologies used in the preparation of paint/coatings formulations.	**3**	**2**	**2**			**2**	**1**	**2**
CO4	Comprehension of properties, constituents and formulations of pigments and dyes, differentiate dyes and pigments, their mechanisms of action and applications.	**3**	**2**	**1**			**1**	**2**	**2**
CO5	Comprehensive understanding of properties, constituents, formulations and uses of varnishes. Develop an appropriate choice of coating material (paint, pigment, dye or varnish) based on the nature of the substrate.	**3**	**2**	**1**			**1**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12.Brief description of self-learning /E-learning component

1. https://www.youtube.com/watch?v=5OxdXq91TV0
2. https://www.youtube.com/watch?v=WQ8v-UcACTE
3. https://www.youtube.com/watch?v=Keff0zA7Zq8
4. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/116102052/lec3.pd
5. https://www.oreilly.com/library/view/basic-civil-engineering/9788131729885/xhtml/chapter010.xhtml

13. Books recommended:

1. Friction and Lubrication of Solids - Bowden, F.P. and D. Tabor Part I & II Clare-don Press, Oxford (1954)
2. An Introduction to Metallic Corrosion – 3rd Ed., Ulick R. Evans, Edward Arnold Ltd. And ASM (1981)
3. Corrosion and Corrosion Control 3rd Ed., H.H. Uhling & R.Winston Revie, Wiley- Inter Sciences, New York (1985)
4. Corrosion Engineering, 3rd, Ed., M.G. Fontana, McGraw Hill, New York (1986).

1. Name of the Department: Chemistry						
2. Course Name	PHARMACEUTICAL CHEMISTRY			L	T	P
3. Course Code	CH411			3	1	0
4. Type of Course (use tick mark)				Core (√)	DE ( )	FC ( )
5. Pre-requisite (if any)	B.Sc. with Chemistry	6. Frequency (use tick marks)	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: Students to understand the Synthesis, uses and mode of action of Antibiotics and Sulpha Drugs ,Antipyretics analgesics, Anesthetic drugs, cardiovascular drugs, Drug Design.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluate the concept of antibiotics. Classification, synthesis, mode of action and uses of different types of antibiotics.
CO2	Analyze classification, structure, synthesis and uses of analogues of p-aminophenol, Salicylic acid, Pyrazolones and Pyrazolodinones.
CO3	Create the basic knowledge, Classification, Synthesis and mode of action of Inhalation, Intravenous anesthetics and Basal anesthetics.
CO4	Analyze classes, structure, synthesis and mode of action of cardiac glycosides Digoxin, and Digitoxin; Anti-hypertensive and hypotensive drugs, Antiarrhythmic agents.
CO5	Comprehension of analogues and prodrugs; concept of lead; factors governing drug design; rational approach to drug design; revolutions in drug discovery, research and development strategies.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Antibiotics and Sulpha Drugs

Introduction and classification of antibiotics; beta lactam antibiotics: penicillins, its structure and mode of action, synthesis of Penicillin-v. Cephalosporins: classification, structure and mode of action of first, second, third and fourth generation cephalosporins. Aminoglycoside antibiotics: structure and mode of action of Streptomycin, Neomycin and Kenamycin. Chloramphenicol: its structure, synthesis and mode of action. Synthesis and uses of sulphathiazole, sulphaguanidine, sulphadiazine, sulphamethazine and sulphaacetamide.

Unit-2	Number of lectures =08	Title of the unit: Antipyretics analgesics

Introduction,classification,structure,synthesisandusesofanalogues ofp-aminophenol:Paracetamol,Phenacetinandantifebrin;Salicylicacidanalogues:Aspirin,Salol, Salsalate and benorilate; Pyrazolones and Pyrazolodinones analogues: Antipyrine, Aminopyrin, Dipyrone, Phenylbutazone, Oxyphenbutazone and Sulphinpyrazone

Unit-3	Number of lectures = 08	Title of the unit: Anesthetic drugs

Introduction, Classification, Synthesis and mode of action of; Inhalation anesthetics: Vinyl ether, Cyclopropane and Fluoroxene; Intravenous anesthetics: Thiopental Sodium&MethohexitalSodium;Basalanesthetics:Procaninehydrochloride,Tetracainehydrochloride,Butacainehydrochloride,Benzaminehydrochlorideand Pyrocanine hydrochloride.

Unit-4	Number of lectures = 08	Title of the unit: Cardiovascular drugs

Introduction, classification, structure and mode of action of cardiac glycosides Digoxin, and Digitoxin; Anti-hypertensive and hypotensive drugs: structure, synthesis and modeofactionofLosartan,Clonidine,Hydralazine,MethyldopaandDiazoxide;Antiarrhythmicagents:structure,synthesisandmodeofactionofDiisopyramide, Procainamide, Propranolol, Beritylium Tosilate;Vasopressor drugs: structure, synthesis and mode of action of Isoxsupurine, Pr enyl amine.

Unit-5	Number of lectures = 08	Title of the unit: Drug Design

Introduction; analogues and prodrugs; concept of lead; factors governing drug design; rational approach to drug design; Drug design: the method of variation; Drug design and development: preamble, revolutions in drug discovery, research and development strategies.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Evaluate the concept of antibiotics. Classification, synthesis, mode of action and uses of different types of antibiotics.	3	1	2	2	2	3	2	2
CO2	Analyze classification, structure, synthesis and uses of analogues of p-aminophenol, Salicylic acid, Pyrazolones and Pyrazolodinones.	3	1	2	2	2	3	2	2
CO3	Create the basic knowledge, Classification, Synthesis and mode of action of Inhalation, Intravenous anesthetics and Basal anesthetics.	3	1	2	2	2	3	2	2
CO4	Analyze classes, structure, synthesis and mode of action of cardiac glycosides Digoxin, and Digitoxin; Anti-hypertensive and hypotensive drugs, Antiarrhythmic agents.	3	1	2	2	2	3	3	2
CO5	Comprehension of analogues and prodrugs; concept of lead; factors governing drug design; rational approach to drug design; revolutions in drug discovery, research and development strategies.	3	1	2	2	2	3	2	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=NGwP471sehI
2. https://www.youtube.com/watch?v=Ac6yMWno6yk
3. https://www.youtube.com/watch?v=-UD0y4jdKuc
4. http://nptel.ac.in/courses/104101006/downloads/lecture-notes/mod10/lec3.pdf
5. https://www.youtube.com/watch?v=2vLDzMSo2Tc&list=PLg8Xhs-vwgxLSKf7XRqynIrY6aGHseZry&index=43

13. Books recommended:

1. Burger's Medicinal Chemistry: Mangrove E. Wolff, 4th Edition, John Wiley and Sons
2. Medicinal Chemistry by Asutosh Kar , New Age International publication
3. Principles of Medicinal Chemistry: W.O.Foye.
4. The Pharmacological Basis of Theraputics : L.S. Goodman and A.Gilman
5. Wilson's Medicinal Chemistry The Organic Chemistry of Drug Synthesis: D. Lednicer and L.A.Mitscher

1.Name of the Department: Chemistry						
2.Course Name	**SURFACE CHEMISTRY AND ELECTROCHEMISTRY**			**L**	**T**	**P**
3.Course Code	**CH420**			3	1	0
4.Type of Course (use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (If any)	B.Sc. with Chemistry	**6.Frequency(usetickmarks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem( )
7.Total Number of Lectures, Tutorials, Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: Students gain the knowledge of secondary plant metabolites such as terpenoids, alkaloids, carbohydrates, Amino Acid, Peptides & Proteins, steroids, Synthesis and medicinal uses of; caffeine, theophylline, theobromine and Phytopharmaceuticals.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would develop concept of monolayer and multilayer adsorption; perceive the different theory of adsorption *viz*, Langmuir, Freundlich and Gibbs adsorption isotherm and their applications. They also got insight the importance of various techniques to characterize surface of different system.
CO2	Students would able to recognize the role of surface active reagents and thermodynamics of micellization, stabilization, microemulsion, reverse micelles and get sound insight of potential develop between solid and liquid i.e. zeta potential.
CO3	Students would able to differentiate between ionic and molar conductivity for strong and weak electrolyte and understand the concept of electrical double layer and Butler –Volmer equation.
CO4	Students would able to distinguish difference between galvanic and electrolytic cell; perceive the concept of Nernst equation and thermodynamics of electrochemical cell. They also got the sound understanding of polarization and overvoltage.
CO5	Students would able to understand the role of electrochemistry for analysis of corrosion phenomenon and identify the different electrochemical energy resources.

10.Unit wise detailed content

Unit-1	Number of lectures=08	Title of the unit: Process at Solid Surface

Growth and structures of solid surfaces, Physisorption and Chemisorption, Freundlich, Langmuir and BET isotherms, Gibbs Adsorption isotherm, dissociative adsorption, temperature dependence of adsorption, sticking probability. Surface analytical techniques, spectroscopies (Auger, photoelectron and vibrational) temperature programmed techniques, Surface imaging electron microscopy.

Unit-2	Number of lectures=08	Title of the unit: Surface and Interface

Surface active reagents, classification of surface active reagents, micellization, hydrophobic and hydrophilic interaction, critical micelle concentration(CMC), kraft temperature, factors affecting CMC of surfactant, counter ion binding to micelle, thermodynamics of micellization, stabilization, microemulsion, reverse micelles, surface films(electrokinetics phenomenon) Zeta potential.

Unit-3	Number of lectures=08	Title of the unit: Conductance and Ionization

Ionic conductance, drift speed, electrical force, molar conductivity, strong and weak electrolytes and their molar conductance, law of independent migration of ions: Kohlraush's law, Ostwald's dilution law, conductometric and potentiometric titrations. Electrical double layer, ficks first and second law of diffusion, Tafel plot, process at electrode-Butler-Volmer equation and its applications.

Unit-4	Number of lectures=08	Title of the unit: Electrochemical Cells

Daniell reversible and irreversible cells, cell representations and half cell reactions, E.M.FF., Thermodynamics of electrochemical systems: Nernst equations, varieties of electrodes, standard electrode potential. Type of boundary between half cell and liquid junction potentials, Concentration cells, Applications of EMF measurements-determination of activity coefficient, composition of complex ions, solubility products, measurement of pH and pKa (Hydrogen, Quinhydrone, Glass electrodes), Polarization, Overvoltage.

Unit-5	Number of lectures=08	Title of the unit: Corrosion and Conversion of Electrochemical Energy

Introduction, definition and types, mechanism of electrochemical corrosion, methods of prevention of corrosion , dry cells, lead batteries, alkaline cells (Edison cell), Fuel cells, Biological energy and conversions.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students would develop concept of monolayer and multilayer adsorption; perceive the different theory of adsorption *viz*, Langmuir, Freundlich and Gibbs adsorption isotherm and their applications. They also got insight the importance of various techniques to characterize surface of different system.	**3**	**1**	**3**	**1**		**3**	**3**	**3**
CO2	Students would able to recognize the role of surface active reagents and thermodynamics of micellization, stabilization, microemulsion, reverse micelles and get sound insight of potential develop between solid and liquid i.e. zeta potential	**3**	**1**	**3**	**1**		**3**	**2**	**3**
CO3	Students would able to differentiate between ionic and molar conductivity for strong and weak electrolyte and understand the concept of electrical double layer and Butler –Volmer equation.	**3**	**1**	**2**	**1**		**3**	**2**	**2**
CO4	Students would able to distinguish difference between galvanic and electrolytic cell; perceive the concept of Nernst equation and thermodynamics of electrochemical cell. They also got the sound understanding of polarization and overvoltage.	**3**	**1**	**2**	**1**		**2**	**1**	**3**
CO5	Students would able to understand the role of electrochemistry for analysis of corrosion phenomenon and identify the different electrochemical energy resources.	**3**	**1**	**3**	**1**		**2**	**2**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/content/storage2/courses/103103026/pdf/mod2.pdf
2. https://www.youtube.com/watch?v=zdhDei1JoII
3. https://www.youtube.com/watch?v=R2UhAdqiXbs
4. http://www.umich.edu/~chem260/fall01/lecture37.pdf
5. http://www.griet.ac.in/nodes/EC_UNIT_2.pdf

13. Books recommended:

1. Bard A J Faulkner LR , Electrochemical Methods: Fundamentals and APPLICATIONS 2nd Edition John Willy & Sons New York 2002.
2. Bockris J O M, Reddy A K N, Modern Electrochemistry 1: Ionic 2nd Edition Springer 1998.
3. Atkins P, Paula J Diver and Atkins Physical Chemistry 8th Edition Oxford 2016.
4. Puri, Sharma, L.R., and Pathania, M.S.,Principles of Physical Chemistry 50th Edition, Vishal publishing Co.

1.Name of the Department: Chemistry						
2.Course Name	**COORDINATION AND ORGANOMETALLIC CHEMISTRY OF TRANSITION ELEMENTS**			**L**	**T**	**P**
3.Course Code	**CH421**			3	1	0
4.Type of Course(use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (if any)	B.Sc. with Chemistry	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	EverySem( )
7.Total Number of Lectures,Tutorials,Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: Students gain the knowledge of secondary plant metabolites such as terpenoids, alkaloids, carbohydrates, Amino Acid, Peptides & Proteins, steroids, Synthesis and medicinal uses of; caffeine, theophylline, theobromine and Phytopharmaceuticals.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will have a firm foundation in the approaches of fundamental atomic structure and the periodicity of transition elements in the periodic table.
CO2	Students will have a firm foundation in have a basic understanding of nomenclature for transition metal complexes, chelate / chelation, MoT of the octahedral complxes, prediction of molecular geometries of selected molecular species.
CO3	Students will have a firm foundation in have a basic understanding of magnetism of the complexes.
CO4	Students will be able understand the knowledge in fundamentals of organometallic compounds.
CO5	Students will be able to create the pathways for the organometallic compounds as industrial catalytic applications in the various organic synthesis.

10.Unit wise detailed content

Unit-1	Number of lectures=08	Title of the unit: Basics of Coordination Chemistry

General characteristics properties of transition elements werner's theory effective atomic number shape of d orbitals bonding in transition metal complexes nomenclature of coordination compounds isomerism in coordination compounds polymerization ionisation hydrate linkage coordination position isomerism stereoisomerism geometrical and optical isomerism.

Unit-2	Number of lectures=08	Title of the unit: d-Block Metal Chemistry

valence bond theory and hybridization crystal field theory and splitting TD and c4 v system spectrochemical series and effect of covalency Crystal Field stabilization energy high and low spin octahedral complexes John teller distortion that crystal field and the square planar Crystal Field crystal field theory uses and limitation microstates and term symbols Russell saunders coupling i.e spin orbit coupling ground state of element with z=1-10 , spin Crossover.

Unit-3	Number of lectures=08	Title of the unit: Bonding and Properties of Complexes

High and low spin states, molecular orbital theory, octahedral complexes, nephelauxetic series back bonding involving pi donor and acceptor ligands pi in seo2 and o3 sf6 and HF to organ and tenable sugano diagram electronic absorption spectra of octahedral and tetrahedral complexes charge transfer spectra interpretation of electronic absorption spectra of use of reach parameters magnetic properties of transition metal complexes spin-orbit coupling the effect of temperature on ferromagnetism and antiferromagnetism and ferrimagnetism.

Unit-4	Number of lectures=08	Title of the unit: Organometallic Chemistry of Transition Elements

Organometallic compounds, ligand hapticity ,18 electron rule in metal carbonyls: homiletic and heteroleptic complexes synergistics effort factor affecting the magnitude of stretching frequency synthesis and structure of Fe carbonyl complexes fruits of unity reaction of organometallic compound oxidative addition reductive eliminations, Alkyl ,carbine ,alkene, alkyne,allyl and buta 1-3 diene complexes.

Unit-5	Number of lectures=08	Title of the unit: Application of Organometallic Chemistry

Application of Organometallic Chemistry:- organometallics: organolithium magnesium zinc copper and titanium reagents . Catalytic cycle of wacker process.
Homogenneuos catalysis: alkene (olefin) and alkaline metal, Wikinsons catalytic cycle, hydroformylation (oxo-process) ,
Heterogeneous catalysis: commercial application: Ziegler-Natta catalysis and haber process.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students will have a firm foundation in the approaches of fundamental atomic structure and the periodicity of transition elements in the periodic table.	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**2**
CO2	Students will have a firm foundation in the basic understanding of nomenclature for transition metal complexes, chelate / chelation, MoT of the octahedral complexes, prediction of molecular geometries of selected molecular species.	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**2**
CO3	Students will have a firm foundation in basic understanding of magnetism of the complexes.	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**
CO4	Students will be able understand the knowledge in fundamentals of organometallic compounds.	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**
CO5	Students will be able to create the pathways for the organometallic compounds as industrial catalytic applications in the various organic syntheses.	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/104/101/104101121/
2. https://nptel.ac.in/content/syllabus_pdf/104101090.pdf
3. http://www.ncert.nic.in/ncerts/l/lech109.pdf
4. https://nptel.ac.in/courses/104103022/
5. https://nptel.ac.in/courses/104103071/

13. Books recommended:

1. F. Albert cotton, Geoffrey Wikinson, Carlos A,Murillo and Manfred Bochmann. Advanced inorganic chemistry, 6th edition, wiley India Pvt LTD.
2. J.D Lee. Concise inorganic Chemistry, 5th edition, Wiley India Pvt LTD.
3. JH Huheey , inorganic chemistry- principles, structure and reactivity , Harper and Row publisher Inc . New York (1972).

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1. Name of the Department: Chemistry						
2. Course Name	**CHEMISTRY LAB PRACTICAL-2**			**L**	**T**	**P**
3. Course Code	**CH422**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. COURSE OBJECTIVES: Imparting of scientific methodology, Development of practical/technical skills, The ability to work effectively and safely in a laboratory environment, Developing transferable skills (team work, time management), Enhancing communication skill.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the basic analytical and technical skills to work effectively in the various fields of chemistry
CO2	Able to detect adulterants in the given food sample.
CO3	Know the determination of strength of acid, optical rotation of cane sugar. Saponification value of oil, acid value of oil. Isolation of lycopene, nicotine, lactose and casein, lecithin Caffeine from tea. Preparation of Acetanilide, Aspirin, Paracetamol.
CO4	Remember to keep records of all performed experiments in the manner, which is required in laboratory.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. List of experiments

1. Determination of strength of acid against strong base by pH meter.
2. Measurement of surface tension of a liquid by capillary rise method
3. Determination of optical rotation of cane sugar.
4. Determination of saponification value in the given oil.
5. Determination of acid value in the given oil.
6. Estimation of amino acid.
7. Estimation of Glucose.
8. Separation of essential oils by soxhlet extractor.
9. Isolation of Lycopene from tomato.
10. Isolation of Nicotine from tobacco.
11. Isolation of Lactose and caesin from milk.
12. Isolation of lecithin from egg yolk.
13. Isolation of Caffeine from tea.
14. Preparation of Magnesium bisilicate (antacid).
15. Preparation of Paracetamol.
16. To prepare the iron(III) ethylenediaminetetraacetalato complex, $Na[Fe(EDTA)]\cdot 3H_2O$

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Understand the basic analytical and technical skills and to work effectively in the various fields of chemistry	**3**	**1**	**1**	**1**		**2**	**1**	**2**
CO2	Able to detect adulterants in the given food sample.	**3**	**1**	**3**	**1**		**3**	**3**	**2**
CO3	Know the determination of strength of acid, optical rotation of cane sugar. Saponification value of oil, acid value of oil. Isolation of lycopene, nicotine, lactose and casein, lecithin Caffeine from tea. Preparation of Acetanilide, Aspirin, Paracetamol.	**3**	**1**	**1**	**1**		**2**	**1**	**2**
CO4	Remember to keep records of all performed experiments in the manner, which is required in laboratory.	**3**	**1**	**1**	**1**		**2**		
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**	**1**		**2**	**1**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self- learning / E-learning component

1. https://www.youtube.com/watch?v=MTsn1-ToKqQ
2. http://www.bellevuecollege.edu/wp-content/uploads/sites/140/2014/06/aspirin_tablets_titration.pdf
3. https://www.frontiersin.org/articles/10.3389/fonc.2015.00196/full
4. https://www.youtube.com/watch?v=1tmqUVSVPo4
5. https://www.youtube.com/watch?v=KZ35K05SA7g
6. https://www.youtube.com/watch?v=249FNCSR-Cw
7. https://www.niser.ac.in/sps/sites/default/files/basic_page/Surface%20tension%20by%20capillary%20rise%20method_%202018.pdf

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.
2. Practical Organic Chemistry A.I. Vogel.
3. Practical Physical Chemistry: B. Viswanathan and P.S. Raghavan.
4. Experimental Inorganic Chemistry –W.G.Palmer.

1. Name of the Department: Chemistry						
2. Course Name	**POLYMER CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH501**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The main objective of this course is to study the mechanism of polymer preparation, their processing techniques, commercial uses, identification techniques and preparation process of vinyl polymers, polyamides, polyesters, synthetic rubbers, cellulose and copolymer resins

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Evaluate the different mechanisms of polymer preparation and their classification.
CO2	Understand the colligative properties of Polymers and evaluate the identification techniques such as IR, NMR of Polymers.
CO3	Analyze various processing techniques of Polymer.
CO4	Understand the preparation process of vinyl polymers, polyamide, polyesters and rubber.
CO5	Understand the Vulcanization of Rubber and synthesis of Synthetic Rubber and various other copolymer resins.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Polymer & Polymerization**

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic

Unit-2	**Number of lectures = 08**	**Title of the unit: End group analysis**

Solubility and swelling, Concept of molecular weight distribution and its significance, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, microscopic (optical and electronic) techniques.

Unit-3	**Number of lectures = 08**	**Title of the unit: Polymer processing Techniques**

Commodity and general-purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: Polyurethane, PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex; SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE, Specialty plastics: PEK, PEEK, PPS, PSU, PES etc. Biopolymers such as PLA, PHA/PHB.

Unit-4	**Number of lectures = 08**	**Title of the unit: Some Commercially important Polymers**

Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites. Polymer reinforcement, reinforcing fibers – natural and synthetic, base polymer for reinforcement (unsaturated polyester), ingredients / recipes for reinforced polymer composite.

Unit-5	**Number of lectures = 08**	**Title of the unit: Vulcanization of rubber**

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics (Antioxidants, Light stabilizers, UV stabilizers, Lubricants, Processing aids, Impact modifiers, Flame retardant, antistatic agents. PVC stabilizers and Plasticizers) and their function, use of carbon black, polymer mixing equipment, cross-linking and vulcanization, vulcanization kinetics

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Evaluate the different mechanisms of polymer preparation and their classification.	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**2**
CO2	Understand the colligative properties of Polymers and evaluate the identification techniques such as IR, NMR of Polymers.	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**2**
CO3	Analyze various processing techniques of Polymer.	**3**	**1**	**2**	**2**	**1**	**3**	**2**	**3**
CO4	Understand the preparation process of vinyl polymers, polyamide, polyesters and rubber.	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**
CO5	Understand the Vulcanization of Rubber and synthesis of Synthetic Rubber and various other copolymer resins.	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**3**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod7.pdf
2. https://www.e-education.psu.edu/matse202/node/712
3. http://eacharya.inflibnet.ac.in/data-server/eacharya documents/55daa452e41301c73a2cb5ac_INFIEP_208/806/ET/lec%20-3.pdf
4. https://nptel.ac.in/content/storage2/courses/103103029/pdf/mod7.pdf
5. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/113105028/lec20.pdf

13. Books recommended:

1. Principles of polymer chemistry: A Ravve, 2nd Edition, Kluwer Academic publications
2. Polymer Science and technology: Joll. R. Fried, Prentice – Hall.
3. Principles of polymer systems: F. Rodriguez, Claude Cohen, C.K. Ober, L.A. Archer, Vth Edition, Taylor & Francis
4. Introduction to polymers: R.J. Young and P.A. Lovell, 2nd Edition, Netron Thornes publications
5. Polymer chemistry – an introduction, Malcolm D. Stevens, Oxford University press.

1. Name of the Department: Chemistry						
2. Course Name	**ORGANIC REACTION, REAGENTS & HETEROCYCLIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH513**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. **COURSE OBJECTIVES:** To understand organic name reaction, rearrangement and its mechanism, Use of reagents in organic synthesis, preparation and chemical reactions of heterocyclic compounds.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Mechanistic concept of some name reactions such as Mannich reaction, Stork Enamine reaction, Shapiro reaction, Perkin reaction, Sharpless Asymmetric Epoxidation, Dieckmann condensation and Knoevenagel condensation
CO2	Explain the mechanism of some important rearrangement like Pinacol-pinacolone rearrangements, Benzil-Benzilic acid rearrangements, Curtius rearrangements, Schmidt reaction, Lossen rearrangements, Baeyer Villiger reaction and Favorskii rearrangements
CO3	Analyze and compare the uses of some important reagents in organic transformation like oxidation, reduction, dehydration, alkylation, acylation etc.
CO4	Evaluate the methods for the synthesis of some important five membered heterocyclic compounds and its chemical reaction.
CO5	Comprehension for the synthesis of some important six membered heterocyclic compounds and its chemical reaction.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Name reactions**

Mannich reaction, Stobbe condensation, Stork Enamine reaction, Shapiro reaction, Perkin reaction, Woodward hydroxylation, Prevost hydroxylation, Robinson annulations, Sharpless Asymmetric Epoxidation, Ullmann reaction, Benzoin condensation, Dieckmann condensation and Knoevenagel condensation

Unit-2	**Number of lectures =08**	**Title of the unit: Rearrangements**

Pinacol-pinacolone rearrangements, Wagner-Meerwein rearrangements, Benzil-Benzilic acid rearrangements, Sommelet Hauser rearrangements, Curtius rearrangements, Schmidt reaction, Lossen rearrangements, Neber rearrangements, Baeyer Villiger reaction and Favorskii rearrangements

Unit-3	**Number of lectures = 08**	**Title of the unit: Reagents**

Use of following reagents in organic synthesis: Dicyclohexylcarbodiimide (DCC), Gilman's reagent (lithium dimethyl cuprate), Lithium aluminium hydride (LiAlH4), Sodium borohydride (NaBH4), Lithium diisopropylamide (LDA), trimethylsilyl iodide, Wilkinson's catalyst, Pyridinium Chlorochromate (PCC), Perbenzoic acid

Unit-4	**Number of lectures = 08**	**Title of the unit: Introduction to condensed five membered heterocycles**

Introduction of petroleum refining, cracking, application of cracking, synthetic petrol, Bergius process, Fischer-Tropsh process, octane number, flash point, determination of flash point, synthesis of pure chemicals from petrochemicals.

Unit-5	**Number of lectures = 08**	**Title of the unit: Introduction to condensed six membered heterocycles**

Methods of synthesis with special reference to Knorr synthesis, Pall-Knorr synthesis and Hantzsch synthesis, chemical reactions of pyrrole, furan and thiophene, mechanism of electrophilic substitution reactions of pyrrole, furan and thiophene

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Mechanistic concept of some name reactions such as Mannich reaction, Stork Enamine reaction, Shapiro reaction, Perkin reaction, Sharpless Asymmetric Epoxidation, Dieckmann condensation and Knoevenagel condensation	**3**	**2**	**3**	**2**	**1**	**2**	**3**	**3**
CO2	Explain the mechanism of some important rearrangement like Pinacol-pinacolone rearrangements, Benzil-Benzilic acid rearrangements, Curtius rearrangements, Schmidt reaction, Lossen rearrangements, Baeyer Villiger reaction and Favorskii rearrangements	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**
CO3	Analyse and compare the uses of some important reagents in organic transformation like oxidation, reduction, dehydration, alkylation, acylation etc.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**
CO4	Evaluate the methods for the synthesis of some important five membered heterocyclic compounds and its chemical reaction.	**3**	**2**	**3**	**2**	**1**	**2**	**3**	**3**
CO5	Comprehension for the synthesis of some important six membered heterocyclic compounds and its chemical reaction.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.organic-chemistry.org/namedreactions/beckmann-rearrangement.shtm
2. https://www.youtube.com/watch?v=F_xKfs4gzLg
3. https://nptel.ac.in/courses/104/103/104103111/
4. https://www.youtube.com/watch?v=lG-4TJsAwGY
5. https://nptel.ac.in/courses/104/105/104105034/

13. Books recommended:

1. Advanced Organic Chemistry (Reactions, Mechanisms and Structure): Michel B. Smith and Jerry March, 4th Edition, Wiley Interscience Publication.
2. A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Six edition, Pearson publication.
3. Organic Chemistry by Robert Thornton Morrison, Robert Neilson Boyd, and Saibal Kanti Bhattacharjee, Seventh edition, Pearson publication.
4. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren, Second edition, Oxford Publication.
5. Organic Chemistry by T.W.Graham Solomons, and Craig B. Fryhle, Ninth edition, Wiley Publication.
6. Organic Chemistry by IL Finar, Volume 1 & 2, Sixth edition, Pearson Publication.
7. Designing organic synthesis by S. Warren, Wiley.
8. Some Modern methods of organic synthesis by – W. Carruthers, Cambridge.
9. Heterocyclic Chemistry by raj K Bansal, New Age International

1. Name of the Department: Chemistry						
2. Course Name	**CHEMICAL KINETICS AND CHEMICAL EQUILBRIUM**			**L**	**T**	**P**
3. Course Code	**CH514**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: This course is designed for postgraduate students of chemistry as a broad base introduction to chemical kinetics and chemical equilibrium. After successfully completion of course, the student will able understand the chemical dynamics of complex reaction and their mechanism. Interestingly, it also deals with homogenous catalysis and its applications.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would able to analyze theories of reaction rates by taking collision theory of bimolecular reaction and activated complex, as a reference and also understand the how the concentration of inert salt affect the rate of chemical reaction.
CO2	Students evaluate fundamentals of Homogeneous catalysis with reference of Enzyme catalysis. They got sound inside of affect solvent on the rate of chemical reaction.
CO3	Students would develop the concept of chemical dynamics; Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theory. They got the sound insight of fast reactions by flow method, Relaxation method, and Flash photolysis and their applications in research.
CO4	Students would develop the concept of spontaneity; ΔG and how the Van't Hoff equations play very important role in homogeneous as well heterogeneous equilibrium. They got the sound insight with reference of Le-Chatelier's principle and its industrial applications.
CO5	Students would able to illustrate how the ionic strength is affecting activity coefficient and mean activity coefficient of electrolytes. They also got the concept of Debye-Huckel limiting law and its importance.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Theories of Reaction Rates**

Kinetic theory of collision, Steric factor, Extension of collision theory, Conventional transition state theory, Thermodynamics aspects of CTST, Kinetic and thermodynamic control of reactions, Salt effects, Steady state kinetics, Kinetic isotopic effect.

Unit-2	**Number of lectures = 08**	**Title of the unit: Solution Kinetic**

Homogeneous catalysis (acid-base catalysis), Enzyme kinetics – Michaelis-Menten kinetics, Lineweaver-Burk plot, Enzyme inhibition; competitive and noncompetitive, Factors affecting the rate reaction in solutions, Effect of solvent on reaction rates.

Unit-3	**Number of lectures = 08**	**Title of the unit: Chemical Dynamics**

Unimolecular reactions and their treatments (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theory), Complex reactions (chain reactions, and oscillatory reactions), Studies of fast reactions by flow method, Relaxation method, Flash photolysis.

Unit-4	**Number of lectures = 08**	**Title of the unit: Chemical Equilibrium**

Spontaneity of chemical reactions; Gibbs energy minimum; Perfect gas equilibria; Gibbs free energy change for the reaction and chemical quotient; Expression for thermodynamic equilibrium constant; Equilibrium Calculations, Response of equilibrium to pressure, volume and temperature, The van't Hoff equation, Le-Chatelier's principle.

Unit-5	**Number of lectures = 08**	**Title of the unit:**

Ionic strength, Activity coefficient and mean activity coefficient of electrolytes, Debye-Hückel theory of strong electrolytes, Debye-Huckel limiting law, Electrified interfaces, Overpotential, Electrolytic conductivity.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students would able to analyze theories of reaction rates by taking collision theory of bimolecular reaction and activated complex, as a reference and also understand the how the concentration of inert salt affect the rate of chemical reaction.	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**3**
CO2	Students evaluate fundamentals of Homogeneous catalysis with reference of Enzyme catalysis. They got sound inside of affect solvent on the rate of chemical reaction.	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**3**
CO3	Students would develop the concept of chemical dynamics; Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theory. They got the sound insight of fast reactions by flow method, Relaxation method, and Flash photolysis and their applications in research.	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**
CO4	Students would develop the concept of spontaneity; ΔG and how the Van't Hoff equations play very important role in homogeneous as well heterogeneous equilibrium. They got the sound insight with reference of Le-Chatelier's principle and its industrial applications.	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**3**
CO5	Students would able to illustrate how the ionic strength is affecting activity coefficient and mean activity coefficient of electrolytes. They also got the concept of Debye-Huckel limiting law and its importance.	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**3**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/content/storage2/courses/122101001/downloads/lec-32.pdf
2. https://www.youtube.com/watch?v=gN-yU0MDFzE
3. https://www.youtube.com/watch?v=c34viSd-dVA
4. https://www.khanacademy.org/science/chemistry/chemical-equilibrium

13. Books recommended:

1. Physical Chemistry, P.W.Atkins and J. D. Paulo, Oxford, 2013, 10th edition New Delhi.
2. Chemical Kinetics, K.J. Laidler, Mcgraw-Hill.
3. Physical Chemistry, Geoge Woodbury, Brooks/ Cole Publishing, 1997, Pacific Grove, USA.
4. Physical Chemistry, T. Engel and P. Reid, Pearson, 2006, 1st edition, New Delhi.
5. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J.Kuriacose, McMillan.

1. Name of the Department: Chemistry						
2. Course Name	**INORGANIC REACTIONS, MECHANISM AND CATALYSIS**			**L**	**T**	**P**
3. Course Code	**CH515**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: To comprehend inorganic reaction mechanisms, influencing factors, and the significance of inorganic elements in context with bio-inorganic chemistry.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Explanation of the basic concepts related to stability of coordination complexes and an elementary idea will be imparted regarding the basics of reaction mechanisms.
CO2	Detailed study and analysis of reaction mechanisms in coordination complexes will be discussed along with the factors affecting the rate of reactions.
CO3	Inculcation of higher order thinking ability in students to comprehend the inner and outer sphere reactions.
CO4	Set the overture of Bio-inorganic chemistry along with the elucidation of the role of inorganic elements in the metabolism.
CO5	Comprehension of the structure, functioning and role of important bio-inorganic moieties as well as the role of metal ions in body.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Types of Mechanisms**

Basic concepts as kinetic and thermodynamic stability and lability, stability constants; HSAB principle, Factors affecting the stability of complexes with special emphasis to chelate effect and macrocyclic effect.

Unit-2	**Number of lectures = 08**	**Title of the unit: Types of Mechanisms: Substitution Reactions in Coordination Compounds**

Substitution reactions in coordination compounds: Substitution reactions in square planar complexes, Trans effect, trans series, Substitution in octahedral complexes, SN1, SN2, SNICB mechanisms, steric effects on substitutions.

Unit-3	**Number of lectures = 08**	**Title of the unit: Ligand Transfer and Electron Transfer Reactions in Coordination Compounds**

Inner and outer sphere reactions, Electron Transfer reactions, Potential energy diagrams as a conceptual tool, Marcus equation, Types of and factors affecting electron transfer reactions.

Unit-4	**Number of lectures = 08**	**Title of the unit: Metal Ions in Biological Systems**

(a) Essential and trace metals.
(b)Vitamin B12, methyl cobalamine, Biomethylation.
(c) Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

Unit-5	**Number of lectures = 08**	**Title of the unit:**

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, homocyanins and hemerythrin, model synthetic complexes of iron, and copper Electron Transfer in Biology Structure and function of metalloproteins in electron transport processes-cytochromes and ion sulphur proteins.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Explanation of the basic concepts related to stability of coordination complexes and an elementary idea will be imparted regarding the basics of reaction mechanisms.	**3**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO2	Detailed study and analysis of reaction mechanisms in coordination complexes will be discussed along with the factors affecting the rate of reactions.	**3**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO3	Inculcation of higher order thinking ability in students to comprehend the inner and outer sphere reactions.	**3**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO4	Set the overture of Bio-inorganic chemistry along with the elucidation of the role of inorganic elements in the metabolism.	**3**	**1**	**2**	**2**	**2**	**3**	**3**	**2**
CO5	Comprehension of the structure, functioning and role of important bio-inorganic moieties as well as the role of metal ions in body.	**3**	**1**	**2**	**2**	**2**	**3**	**2**	**2**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=dFfv_jC3_ZY
2. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Introduction_to_Inorganic_Chemistry/05%3A_Coordination_Chemistry_and_Crystal_Field_Theory/5.12%3A_Ligand_Substitution_Reactions
3. https://bnmu.ac.in/DetailOnline.aspx?Id=388
4. https://link.springer.com/chapter/10.1007/978-94-011-0255-1_17

13. Books recommended:

1. Inorganic Chemistry – Principles of Structure and Reactivity", J. E. Huheey, E. A. Keiter and R. L. Keiter, 4th edition. Harper Collins College Publ. New York.
2. Mechanism of Inorganic Reactions in Solution – An Introduction", D. Benson, McGraw –Hill.
3. Mechanisms of Inorganic Reactions, by C.F.Basolo and R.G.Pearson, Wiley, New York.
4. d- and f- block Chemistry, C. J. Jones, Tutorial Chemistry Texts, E. W. Abel (Ed.), Royal Society of Chemistry, Cambridge.
5. Basic Inorganic Chemistry, F. A. Cotton and G. Wilkinson, Wiley Eastern Ltd., New Delhi

1. Name of the Department: Chemistry						
2. Course Name	QUANTUM CHEMISTRY: A MOLECULAR APPROACH			L	T	P
3. Course Code	CH516			3	1	0
4. Type of Course (use tick mark)				Core ( )	DE (√)	FC ( )
5. Pre-requisite (if any)	BSc. with Chemistry	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: Quantum chemistry uses high-level mathematics as a tool to understand atomic and molecular structure, properties, energy as well as chemical reactivity. It introduces the mathematical foundations of a variety of wave functions as well as a practical, hands-on experience. The main objective of computational chemistry is to solve chemical problems by simulating chemical systems (molecular, biological, materials) in order to provide reliable, accurate and comprehensive information at an atomic level.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Apply the knowledge of matrices to solve the problems.
CO2	Understand the basic concepts and ideas of Quantum Mechanics.
CO3	Solve the time dependent Schrödinger-equation for discrete two-level systems and being able to apply this to simple problems involving electron spin and photon polarization.
CO4	Apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms.
CO5	To understand analysis of indeterminate structures and adopt an appropriate structural analysis technique

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Elementary Mathematical Concept

Matrices (2x2, 3x3) only, Multiplication, inverse of matrix, (identity matrix) 2x2, 2x3,3x3), commutative properties of matrices, complex number Z and its complex conjugate Z*, Expansion of series [ex, sinx, cosx, ln(1+x), , ln(1-x)], stirling approximation,

Unit-2	Number of lectures =08	Title of the unit: Introductory Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (without derivation) their solution of overall solution and its defects, Compton effect, de-Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian Operator.

Unit-3	Number of lectures = 08	Title of the unit: Elementary Quantum Mechanics-I

Postulates of quantum mechanics, Eigen value equations & function, concept of Wave function, normalization and orthogonalization of wave function, Quantum mechanical operator, commutation of operators, Time dependent and time independent Schrödinger wave equation and its importance.

Unit-4	Number of lectures = 08	Title of the unit: Elementary Quantum Mechanics-II

Particle in a one dimensional box, physical interpretation of the wave function, radial node, wave function and shape of orbital, radial probability density, Angular momentum in quantum mechanics (Lx, Ly, Lz), Harmonic oscillator, Rigid rotor.

Unit-5	Number of lectures = 08	Title of the unit: Approximate Methods

The variation theorem, Perturbation theory (first order and non- degenerate). Applications of variation method and pertubation theory of the Hydrogen atom. Molecular Orbital Theory Huckel theory of conjugated systems, Bond order and charge density calculations, Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Apply the knowledge of matrices to solve the problems.	2	1	2	1	1	2	2	2
CO2	Understand the basic concepts and ideas of Quantum Mechanics.	2	1	2	1	1	2	2	2
CO3	Solve the time dependent Schrödinger-equation for discrete two-level systems and being able to apply this to simple problems involving electron spin and photon polarization.	2	1	2	1	1	2	2	2
CO4	Apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms.	2	1	2	1	1	2	1	2
CO5	To understand analysis of indeterminate structures and adopt an appropriate structural analysis technique	3	1	2	1	1	2	2	2

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.khanacademy.org/math/precalculus/x9e81a4f98389efdf:matrices/x9e81a4f98389efdf:mat-intro/a/intro-to-matrices
2. https://www.youtube.com/watch?v=8JF6lvPBAzk
3. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph03/
4. https://www.youtube.com/watch?v=SQmj5jT2VLU

13. Books recommended:

1. Physical Chemistry, P.W. Atkins, Oxford Press. 7thEdn.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Modern Spectroscopy, J.M. Hollas, John Wiley.
5. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
6. Basic Principles of Spectroscopy, R. Chang, McGraw Hil

1. Name of the Department: Chemistry						
2. Course Name	**BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH506**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The course aims at providing understanding of the chemistry of d-block metals in metalloproteins and of metal based bioactive compounds, fundamentals of molecular recognition, interactions responsible for the formation of supramolecular systems and on the use of metals in medicine.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Student would be able to understand the role of ions in biological system.
CO2	Students evaluate fundamentals of enzyme reactions and metalloenzymes.
CO3	Students would develop the concept of metal acid reactions, and administration of drugs.
CO4	Students would restate difference between different modes of molecular reactions.
CO5	Students would able to apply the concepts of supramolecular chemistry.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Metal ions in Biological functions**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Unit-2	**Number of lectures = 08**	**Title of the unit: Metalloenzymes**

Enzyme, coenzyme, apoenzyme and holoenzyme, Zinc enzymes: carboxypeptidase, carbonic anhydrase and alcohol dehydrogenase. Iron enzymes-catalase and peroxidase. Copper enzymes -superoxide dismutase. Molybdenum enzymes –xanthine oxidase.

Unit-3	**Number of lectures = 08**	**Title of the unit: Metal-Nucleic Acid Interactions**

Metals used for diagnosis and chemotherapy with particular reference to anticancer drugs. cis-platin-indication and contra indications. Administration of drug and its antidote. Reaction, use of antihistamine, mannitol, epinephrine and steroid preparation of drug administration.

Unit-4	**Number of lectures = 08**	**Title of the unit: Supramolecular Chemistry**

Concepts and language. Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.

Unit-5	**Number of lectures = 08**	**Title of the unit: Applications of Supramolecular Species/Compounds**

(A) Supramolecular reactivity and catalysis. (B) Transport processes and carrier design. (C) Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices. (D) Some example of self-assembly in supramolecular chemistry.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Student would be able to understand the role of ions in biological system.	**3**	**1**	**1**	**3**	**2**	**3**	**3**	**3**
CO2	Students evaluate fundamentals of enzyme reactions and metalloenzymes.	**3**	**1**	**1**	**3**	**1**	**3**	**3**	**3**
CO3	Students would develop the concept of metal acid reactions, and administration of drugs.	**3**	**1**	**1**	**3**	**1**	**3**	**3**	**2**
CO4	Students would restate difference between different modes of molecular reactions.	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**2**
CO5	Students would able to apply the concepts of supramolecular chemistry.	**3**	**2**	**1**	**3**	**3**	**3**	**3**	**2**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. http://chemistry.du.ac.in/study_material/4102-B/1.%20Role%20of%20Metal%20Ions%20in%20Biological%20Systems.pdf
2. https://www.rsc.org/events/detail/46673/natural-and-artificial-metalloenzymes-faraday-discussion
3. https://www.youtube.com/watch?v=1Wc4jTH2v_w
4. https://www.youtube.com/watch?v=QQRpcot0k_I
5. https://www.frontiersin.org/journals/chemistry/sections/supramolecular-chemistry

13. Books recommended:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University
3. Science Books.
4. Inorganic Biochemistry vols I and II. ed. G.L. Eichhorn, Elsevier.
5. Progress in Inorganic Chemistry, Vols 18 and 38 eds. J.J. Lippard, Wiley.
6. Supramolecular Chemistry, J.M. Lehn, VCH.
7. Bioinorganic Chemistry, M.N. Hughes, Wiley.

1. Name of the Department: Chemistry						
2. Course Name	**CHEMISTRY LAB PRACTICAL-III**			**L**	**T**	**P**
3. Course Code	**CH517**			0	0	8
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	BSc. with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**		**Practical = 08**		

8. COURSE OBJECTIVES: Imparting of scientific methodology, Development of practical/technical skills, the ability to work effectively and safely in a laboratory environment, developing transferable skills (team work, time management), Enhancing communication skill.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the basic analytical and technical skills and technical skills to work effectively in the various fields of chemistry
CO2	Able to prepare Phenol formaldehyde resin, Urea formaldehyde resin, Nylon 66, soap, shampoo, vanishing cream, hand lotion, lather shaving cream
CO3	Know about the Estimation of ascorbic acid, calcium thioglycolate, lakes and fillers, zinc-pyrithione, acetic acid, protein content, fat content, salt content, moisture content
CO4	Remember to keep records of all performed experiments in the manner which is required in laboratory.
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.

10. List of experiments

Preparation of Phenol formaldehyde resin.

2. Preparation of Urea formaldehyde resin.

3. Preparation of Nylon 66.

4. Synthesis of Dibenzal acetone from benzaldehyde.

5. Sandmeyer reaction: p-chlorotoluene from p-toluidine.

6. Compare the strength of HCl and H2SO4 by studying the rate of hydrolysis of methyl acetate.

7. Determination of sugar/glucose content in the given sample of food.

8. Estimation of ascorbic acid in the given fruit juice.

9. Observe the effect of (Temperature) on equilibrium systems on Cobalt (II) Chloride Complex

10. To determine the solubility product for sparingly soluble salt (e.g. lead sulphate or bariu Sulfate).

Effect of concentration: The purpose of this part is to observe the effect of certain stresses (ion concentration) on equilibrium systems.

12. The equilibrium between Fe^{3+} and $Fe(CNS)^{2+}$.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Understand the basic analytical and technical skills and technical skills to work effectively in the various fields of chemistry	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**2**
CO2	Able to prepare Phenol formaldehyde resin, Urea formaldehyde resin, Nylon 66, soap, shampoo, vanishing cream, hand lotion, lather shaving cream	**3**	**1**	**3**	**1**	**1**	**3**	**3**	**2**
CO3	Know about the Estimation of ascorbic acid, calcium thioglycolate, lakes and fillers, zinc-pyrithione, acetic acid, protein content, fat content, salt content, moisture content	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**2**
CO4	Remember to keep records of all performed experiments in the manner which is required in laboratory.	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**1**
CO5	Analyze the importance of personal safety and care of equipment's and chemicals.	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**3**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self- learning / E-learning component

1. http://www.khalidshadid.com/uploads/3/9/2/0/3920808/phenol_formaldehyde_resin.pdf
2. http://www.inference.org.uk/sustainable/LCA/elcd/external_docs/n66_311147f8-fabd-11da-974d-0800200c9a66.pdf
3. https://www.youtube.com/watch?v=eA9I2MkWMW0
4. https://www.youtube.com/watch?v=Tu_sWoHULtY
5. https://pubs.acs.org/doi/abs/10.1021/ac60157a011
6. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod1.pdf
7. http://www.denverinstrument.com/denverusa/media/pdf/titration_notes/food_beverage/Determination_of_Salt_in_Butter.pdf
8. http://dmsc2.dmsc.moph.go.th/webroot/drug/km/lab_analysis/Karl%20Fischer%20Titration.pdf

13. Books recommended:

1. Advance Practical Chemistry: Jagdamba Singh, L.D.S Yadav, Jaya Singh, I.R. Siddiqui, Pragati Edition.
2. Practical Organic Chemistry A.I.Vogel.
3. Practical Physical Chemistry: B. Viswanathan and P.S. Raghavan.
4. Experimental Inorganic Chemistry – W.G.Palmer.

1. Name of the Department: Chemistry						
2. Course Name	**MOLECULAR SPECTROSCOPY AND SPECTRAL TECHNIQUES**			**L**	**T**	**P**
3. Course Code	**CH518**			3	1	0
4. Type of Course (use tick mark)				**Core (√)**	**DE ( )**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. **COURSE OBJECTIVES:** The main aim of this course is to provide students a concept about how to commonly used molecular spectroscopy techniques work, a theoretical knowledge of each of these methods and their usage in molecular and electronic structure determination.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To understand the significance of group theory for chemistry, which allow the prediction of many molecular properties.
CO2	Can explain vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum. rotational and vibrational Raman Spectra and PQR branches.
CO3	Understand rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines.
CO4	To learn Basic principles, Zero field splitting and Kramer's degeneracy, Factors affecting the 'g' value, hyperfine coupling constants, hyperfine splitting, Spin, Hamiltonian, Measurement techniques
CO5	Students will be able to understand the basics of Mossbauer/ NRF spectroscopy

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Concept of Group theory in Chemistry**

Symmetry elements and symmetry operation, definitions of group, subgroup, relationbetween orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies symbols, representations of groups: Cn, Cnv, Cnh, Dnh etc. Character table

Unit-2	**Number of lectures = 08**	**Title of the unit: Vibrational Spectroscopy**

Review of linear harmonic oscillator, energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups., morse potential energy diagram, Franck Condon Principle, vibrational-rotation spectroscopy, PQR branches.

Unit-3	**Number of lectures = 08**	**Title of the unit: Rotational Spectroscopy**

Classification of molecules, rigid rotor model, energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect, stark effect and applications.

Unit-4	**Number of lectures = 08**	**Title of the unit: Electron Spin Resonance Spectroscopy**

Basic principles, Zero field splitting and Kramer's degeneracy, Factors affecting the 'g' value, hyperfine coupling constants, hyperfine splitting, Spin, Hamiltonian, Measurement techniques, calculation of number of signal, degeneracy, Applications.

Unit-5	**Number of lectures = 08**	**Title of the unit: Mossbauer Spectroscopy**

Basic principles of Mossbauer/ NRF spectroscopy, Isomer shift and nuclear Zeeman splitting, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe2+ and Fe3+ compounds including those of intermediate spin, (2) Sn2+ and Sn4+ compounds-nature of M-L bond, coordination number, structure.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	To understand the significance of group theory for chemistry, which allow the prediction of many molecular properties.	**1**	**1**	**1**	**2**	**3**	**3**	**1**	**2**
CO2	Can explain vibrating diatomic molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum. rotational and vibrational Raman Spectra and PQR branches.	**2**	**1**	**1**	**1**	**3**	**2**	**2**	**1**
CO3	Understand rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines.	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
CO4	To learn Basic principles, Zero field splitting and Kramer's degeneracy, Factors affecting the 'g' value, hyperfine coupling constants, hyperfine splitting, Spin, Hamiltonian, Measurement techniques	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO5	Students will be able to understand the basics of Mossbauer/ NRF spectroscopy	**1**	**1**	**2**	**2**	**3**	**2**	**2**	**2**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=WukUvN721Ag
2. https://study.com/academy/lesson/vibrational-spectroscopy-definition-types.html
3. https://www.youtube.com/watch?v=dU38K-5-j1g
4. https://www.youtube.com/watch?v=eZ-Vnj0sS2M
5. https://www.youtube.com/watch?v=Q2Fo5BAReGo

13. Books recommended:

1. Physical Chemistry, P.W. Atkins, ELBS
2. Quantum Chemistry, By I.R.N. Levine, Privatice, Hall of India Ltd.
3. Quantum Chemistry, By R.K. Prasad, new age International.
4. Banwell C. N.; McCash, E. M., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill, New Delhi (2017).

1. Name of the Department: Chemistry						
2. Course Name	**GREEN CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH509**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: This course is designed for postgraduate students of chemistry and industrial chemistry as a broad base introduction to analytical instrumentation techniques for the measurement of different chemical and physical properties of compounds and materials (composition, structure, etc.). After successfully completion of course, the student will able understand the working principal and applications of various modern analytical techniques as well as their operation.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students would able to create new routes for the synthesis of useful compounds without consuming harmful solvents.
CO2	Students would be able to understand the principles of green chemistry
CO3	Students would able to apply the important tools for the synthesis of useful compounds without harming of environment.
CO4	Students would restate difference between different modes of chromatographic separation; apply knowledge of qualitative and quantitative analysis in various fields of chemical, pharmaceutical industry etc.
CO5	Students would able to illustrate the future of green chemistry

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction**

Definition and concept of Green Chemistry, Need for Green Chemistry, Goals of Green Chemistry, Emergence of green Chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit-2	**Number of lectures = 08**	**Title of the unit: Principles of Green Chemistry and Designing a Chemical synthesis**

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit-3	**Number of lectures = 08**	**Title of the unit: Green Synthesis/Reactions-I**

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4- aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol, furfural.2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols). Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

Unit-4	**Number of lectures = 08**	**Title of the unit: Green Synthesis/Reactions-II**

1. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.2. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in Organic Syntheses; Biocatalysis in Organic Syntheses.

Unit-5	**Number of lectures = 08**	**Title of the unit: Future Trends in Green Chemistry**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Students would able to create new routes for the synthesis of useful compounds without consuming harmful solvents.	**3**	**1**	**1**		**2**	**3**	**2**	**3**
CO2	Students would be able to understand the principles of green chemistry	**3**	**1**	**1**		**1**	**3**	**2**	**3**
CO3	Students would able to apply the important tools for the synthesis of useful compounds without harming of environment.	**3**	**1**	**1**		**1**	**3**	**2**	**2**
CO4	Students would restate difference between different modes of chromatographic separation; apply knowledge of qualitative and quantitative analysis in various fields of chemical, pharmaceutical industry etc.	**3**	**2**	**1**		**2**	**3**	**1**	**2**
CO5	Students would able to illustrate the future of green chemistry	**3**	**2**	**1**		**3**	**3**	**1**	**2**

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green-chemistry.html
2. https://www.youtube.com/watch?v=SvRe_wc0w3Q
3. https://extension.harvard.edu/blog/green-chemistry-and-the-future-of-sustainability/

13. Books recommended:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastes & J.K. Warmer: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

1. Name of the Department: Chemistry						
2. Course Name	**COMPUTATIONAL METHODS IN CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH519**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE (√)**	**FC ( )**
5. Pre-requisite (if any)	B.Sc. with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: The objective of this course is to provide introduction to chemoinformatics, Molecular modeling for drug designing and other area of chemistry, informatics and biology.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	The student is expected to achieve a good grasp of the concepts and applications of chemoinformatics.
CO2	Explain the various stages of drug discovery. Explain various structure-based drug design methods, define molecular modeling.
CO3	the student is expected to achieve a better understanding of in-silico drug designing, and the factors influencing drug discovery
CO4	Explain various structure-based drug design methods, bioinformatics in drug development.
CO5	Understand, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, duration of the MD run etc.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to cheminformatics**

Evolution of cheminformatics, history of chemical information science, use of cheminformatics, prospectus of cheminformatics, and history of medicinal chemistry. Prodrugs and soft drugs, drug target, drug solubility, natural resources of lead compounds, pharmacokinetics and drug metabolism. Molecular modeling using computer.

Unit-2	**Number of lectures = 08**	**Title of the unit: Occupational Safety; Molecular modeling**

Introduction, force field, quantum chemistry, Schrödinger equation, potential energy functions, energy minimization, local and global minima, saddle point, grid search. Semi-empirical methods (ZDO, MNDO, AM1, PM3). Molecular mechanics; Definition, balls and springs, force fields, bond-stretching, bond-bending, dihedral motions, out of plane angle potential, non-bonded interaction, coulomb interactions. Derivative methods; Steepest descent, conjugate gradient and Newton-Raphson method.

Unit-3	**Number of lectures = 08**	**Title of the unit: Drug design and discovery (DDD)**

Introduction drug design and discovery, principles of drug development. Bioinformatics in drug development, cheminformatics and pharmacoinformatics. Applications of drug discovery, in-silico drug designing, area influencing drug discovery. Introduction of two and three-dimensional quantitative structure–activity relationship (QSAR) and its role in DDD.

Unit-4	**Number of lectures = 08**	**Title of the unit: Structure-based drug designing (SBDD)**

Introduction, target identification and validation, homology modeling, receptor mapping, active site analysis, pharmacophore mapping and grid maps. Ligand-based drug designing (LBDD); Introduction, lead designing, combinatorial chemistry, high throughput screening (HTS), database generation and chemical libraries, ADME property. Introduction to docking, methods of docking, docking with AutoDock, Vina, Dock etc.

Unit-5	**Number of lectures = 08**	**Title of the unit: Molecular dynamics (MD)**

Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, duration of the MD run. Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	The student is expected to achieve a good grasp of the concepts and applications of chemoinformatics.	**3**	**1**	**1**		**2**	**2**		
CO2	Explain the various stages of drug discovery. Explain various structure-based drug design methods, define molecular modeling.	**3**	**1**	**2**		**2**	**2**		
CO3	the student is expected to achieve a better understanding of in-silico drug designing, and the factors influencing drug discovery	**3**	**1**	**2**		**2**	**2**		
CO4	Explain various structure-based drug design methods, bioinformatics in drug development.	**3**	**1**	**2**		**2**	**3**		
CO5	Understand, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, duration of the MD run etc.	**3**	**1**	**1**		**2**	**3**		

3 Strong contribution, 2 Average contribution, 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://www.youtube.com/watch?v=yX_nPzmTpi8
2. https://www.youtube.com/watch?v=Y3utQZIPJ-4
3. https://www.jubilantbiosys.com/integrated-drug-discovery-services
4. https://www.mt.com/in/en/home/applications/L1_AutoChem_Applications/Process-Safety.html

13. Books recommended:

1. Chapman, Fortran 95/2003 for Scientists and Wngineers, McGraw-Hill International Edition, New York (2006).
2. V. Rajaraman, Computer Programming in Fortran 90 and 95, PHI Learning Pvt. Ltd, New Delhi (1997).
3. W. H. Press, S. A. Teukolsky, W. H. Vetterling, B. P. Flannery, Fortran Numerical Recipes Volume 2 (Fortran 90), Cambridge University Press (1996).
4. R. L. Schwartz, T. Christiansen, L. Wall, Learning Perl Second Edition, O'Reilly Media (1997). 5. Foy, Mastering Perl First Edition, O'Reilly Media (2007)
5.

1. Name of the Department: Chemistry						
2.CourseName	**SEMINAR**			**L**	**T**	**P**
3.CourseCode	**CH520**			0	0	0
4.TypeofCourse(use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (if any)	B.Sc. with Chemistry	**6.Frequency(use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem( )
7.TotalNumberofLectures,Tutorials,Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: The primary objectives of this course are to develop students' communication and discussion skills, increase vocabulary knowledge, learn about communication style, develop learner autonomy, & build confidence to use English for oral presentation. Also to develop the ability to seek clarification and defend the ideas of others effectively.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To develop and improve the communication skills
CO2	To develop discussion and leadership abilities
CO3	Skills for the development of demonstration abilities

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	To develop and improve the communication skills	1	1	2	3	2	2	3	2
CO2	To develop discussion and leadership abilities	1	1	1	2	2	2	2	3
CO3	Skills for the development of demonstration abilities	1	1	3	1	2	2	1	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

1. Name of the Department: Chemistry						
2.Course Name	**PROJECT TRAINING & EVALUATION**			**L**	**T**	**P**
3.Course Code	**CH521**			0	0	0
4.Type of Course(use tick mark)				**Core(√)**	**DE( )**	**FC( )**
5.Pre-requisite (if any)	B.Sc. with Chemistry	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	EverySem( )
7.Total Number of Lectures, Tutorials, Practicals						
Lectures=30		**Tutorials=10**		**Practical=Nil**		

8. COURSE OBJECTIVES: To provide the industrial exposure and enhance technical skills of students.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Hands on training
CO2	Integrate class room theory with industrial practice.
CO3	Understanding professional ethics of industry.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	Hands on training	3	3	3	2	2	3	2	3
CO2	Integrate class room theory with industrial practice.	3	2	3	2	2	2	2	3
CO3	Understanding professional ethics of industry.	3	3	3	2	3	2	1	3

3 Strong contribution, 2 Average contribution , 1 Low contribution