Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.
Accredited with A^{+} by NAAC - IV cycle – CGPA 3.35

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

Semester I & II

Guidelines & Syllabus

DEPARTMENT OF CHEMISTRY

2023-2026

(With effect from the academic year 2023-2024)

Issued from

THE DEANS' OFFICE

Vision

Impart quality education, scientific skills, academic excellence, research attitude and skills to face global challenges

Mission

1. To develop intellectual and professional skills of the students
2. To provide a firm foundation in chemical concepts, laws and theories
3. To sharpen the scientific knowledge
4. To enhance critical thinking, problem solving ability, scientific temper and innovation
5. To apply chemistry in medicine, biology, industry and environment

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEOs	Upon completion of M. Sc. Chemistry Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	M1, M2
PEO2	continue to learn and advance their career in industry both in private and public sectors.	M4 & M5
PEO3	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	M2, M5 & M6

PROGRAMME OUTCOMES (POs)

POs	Upon completion of M.Sc. Chemistry Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	PEO1 & PEO2
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	PEO1, PEO2 & PEO3
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	PEO2
PO4	develop innovative initiatives to sustain eco-friendly environment	PEO1, PEO2
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	PEO2
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	PEO1, PEO2 & PEO3
PO7	learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development.	PEO3

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc Chemistry programme, the graduates will be able to:	Mapping with POs
PSO-1	impart in-depth knowledge about various aspects of chemistry within an environment committed to excellence	PO1
PSO-2	develop critical thinking, technical skills and innovative ideas in analysing and solving problems in the field of chemistry	PO2, PO3
PSO-3	explore and expedite the recent avenues in chemistry research across	PO4

	the globe with professional competency	
PSO-4	inculcate positive approach towards environment and ecology from the chemistry perspective	PO4, PO7
PSO-5	promote entrepreneurial skills and become self-reliant	PO5, PO6

Mapping of PO'S and PSO'S (Science)

POs	PSO1	PSO 2	PSO3	PSO4	PSO5
PO 1	3	3	2	3	2
PO 2	3	2	3	3	3
PO 3	3	3	3	2	2
PO 4	3	3	2	3	3
PO 5	3	3	3	2	3
PO 6	2	3	3	3	2
PO 7	3	2	2	3	2
Total	**20**	**19**	**18**	**19**	**17**
Average	**2.7**	**2.7**	**2.5**	**2.7**	**2.4**

Strong -S (3), Medium – M (2), Low – L (1)

Eligibility Norms For Admission:

A pass in the B. Sc. Chemistry as major with the minimum of 50% in major and major related courses or equivalent examination as per the norms of Manonmaniam Sundaranar University, Tirunelveli. For SC / ST candidates a pass in B.Sc. Chemistry is sufficient.

Duration of the Programme: 2 years

Medium of Instruction: English

Passing minimum

A minimum of 50% in the external examination and an aggregate of 50% is required. There is no minimum pass mark for the continuous internal assessment.

Components

Courses	No. of Courses	Total Marks
Core Courses	8x100	800
Core Practical	4x100	400
Project	1x100	100
Elective courses	6x100	600
Total marks	**19x100**	**1900**

Course Structure

Distribution of Hours and Credits

Course	SEMESTER				Total	
	I	II	III	IV	Hours	Credits
Core– Theory	7(5) +	6(5)+	6 (5) + 6 (5) +	6 (5) + 6 (5)	74	57

Core Practical	7(5) 6 (4)	6 (5) 6 (4)	6 (5) 6 (4)			
Elective Course	5 (3) + 5 (3)	4 (3) + 4 (3)	3 (3) -	4(3)	16 9	12 6
Core Project	-	-	-	10 (7)	10	7
Skill Enhancement Course	-	4 (2)	3 (2)	4 (2)	11	6
Internship/ Industrial Activity	-	-	(2)		-	2
Extension Activity	-	-		(1)	-	1
Total	**30 (20)**	**30 (22)**	**30 (26)**	**30 (23)**	**120**	**91**

Total Number of Hours = **120**

Co-curricular Courses

Course	SEMESTER				Total
	I	II	III	IV	Credits
Life Skill Training –I	-	(1)	-	-	1
Life Skill Training –II	-	-	-	(1)	1
Field Project	-	(1)	-		1
Specific Value-Added Courses	(1)		(1)		2
Generic Value-Added Courses		(1)		(1)	2
MOOC		(1)		(1)	2
Community Engagement Activity (UBA)		(1)			1

Total Number of Credits = **91+10**

Non- academic courses are mandatory and conducted outside the regular working hours.

Courses Offered
Semester I

Course Code	Title of the Course	Hours / Week	Credits
CP231CC1	Core Course I: Organic Reaction Mechanism – I	7	5
CP231CC2	Core Course II: Structure and Bonding in Inorganic Compounds	7	5

CP231CP1	Core Lab Course I: Organic Chemistry Practical	6	4
CP231EC1	Elective Course I a) Nano Materials and Nano Technology	5	3
CP231EC2	Elective Course I b) Pharmaceutical Chemistry		
CP231EC3	Elective Course I c) Analytical Chemistry		
CP231EC4	Elective Course II a) Electrochemistry	5	3
CP231EC5	Elective Course II: b) Molecular Spectroscopy		
CP231EC6	Elective Course II: c) Industrial Products		
	Total	**30**	**20**

Semester II

Course Code	Title of the Course	Hours / Week	Credits
CP232CC1	Core Course III: Organic Reaction Mechanism-II	6	5
CP232CC2	Core Course IV: Physical Chemistry-I	6	5
CP232CP1	Core Lab Course II: Inorganic Chemistry Practical	6 (3+3)	4 (2+2)
CP232EC1	Elective Course III: a) Medicinal Chemistry	4	3
CP232EC2	Elective Course III: b) Green Chemistry		
CP232EC3	Elective Course III: c)Transition Metal Chemistry		
CP232EC4	Elective Course IV: a) Bio Inorganic Chemistry	4	3
CP232EC5	Elective Course IV: b) Material Science		
CP232EC6	Elective Course IV: c) Organometallic Chemistry		
CP232SE1	Skill Enhancement Course I Health Science	4	2
	Total	**30**	**22**

Co-curricular Courses

Semester	Code	Title of the Course	Credit
I & II	PG23LST1	Life Skill Training	1
II & IV	-	MOOC	1+1
II	PG232CE1	Community Engagement Course (CEC)	1
III & IV	PG23LST2	Life Skill Training	1
I	CP231FP1	Field Project	1
I & III	CP231V01 / CP233V01	Specific Value-added Course	1+1
II & IV	PG232V01- PG232V12/ PG234V01- PG234V12	Generic Value-added Course	1+1
		Total	**10**

Specific Value added Course

S. No.	Course code	Title of the course	Total hours
I	CP231V01	Herbal Product Development and Formulation	30

Examination Pattern

i) Core Course / Elective Course

Internal: External–25:75

Continuous Internal Assessment (CIA)

Internal Components and Distribution of Marks

Components	Marks
Internal test (2) (40 marks)	10
Quiz (2) (20 marks)	5
Seminar (10 marks)	5
Assignment: (Model Making, Exhibition, Role Play, Group Discussion, Problem Solving, Class Test, Open Book Test (Minimum three items per course) (30 marks)	5
Total	**25**

Question Pattern

Internal Test	Marks	External Exam	Marks
Part A 4 x 1 (No choice)	4	Part A 10 x 1 (No choice)	10
Part B 3 x 4(Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 3 x 8 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	100

ii) Lab Course:
Ratio of Internal and External= 25:75
Total: 100 marks

Internal Components and Distribution of Marks

Internal Components	**Marks**
Performance of the Experiments	10
Regularity in attending practical and submission of records	5
Record	5
Model exam	5
Total	**25**

Question pattern

External Exam	**Marks**
Major Practical	75
Minor Practical / Spotters /Record	
Total	**75**

iii) Skill Enhancement Course

Ratio of Internal and External = 2**5: 75**

Internal Components and Distribution of Marks

Components	**Marks**
Internal test (2)	10
Quiz (2)	5
Assignment: (Model Making, Exhibition, Role Play, Album, Group Activity (Mime, Skit, Song) (Minimum three items per course)	10
Total	**25**

Question Pattern

Internal Test	**Marks**	**External Exam**	**Marks**
Part A 2 x 2(No Choice)	4	Part A 5 x 2(No Choice)	10
Part B 3 x 4 (Open choice **Three** out of **Five**)	12	Part B 5 x 5 (Open choice any **Five** out **of Eight**)	25
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 8 (Open choice any **Five** out **of Eight**)	40
Total	**25**	**Total**	**75**

iv) Internship/ Industrial Activity

Components	**Marks**
Industry Contribution	50
Report & Viva-voce	50

v) Core Project:

Ratio of Internal and External 25 : 75

Internal (Supervisor)	**Marks**
I Review	5
II Review	5

Report	15
External (External Examiner)	
Report	40
Viva-voce (individual, open viva-voce)	35
Total	**100**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		Marks
Life Skill Training -I	Album (20 pages)	30
	Group Song, Mime, Skit (Group of 5students)	20
	Total	**50**
Life Skill Training -II	Case Study (30 pages)	50
	Total	**50**

External Component

Written Test	Five out of Seven (5 x 10)	50
	Total	**50**

(ii) Field Project:

Components	**Marks**
Field Work	50
Report & Viva-voce	50

(iii) Specific Value-Added Courses & Generic Value-Added Courses:

Components	**Marks**
Internal	25
External	75

(iv) Community Engagement Activity-UBA

Internal Component	
Component	**Marks**
Attendance (Field Work)	30
Participation	20
Total	**50**

External Component

Component	**Marks**
Group Project Report/ Case Study (10-15 pages in print)	50
Total	**50**

Outcome Based Education

(i) Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No	Level	Parameter	Description
1	KI	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis /Creating	The learner creates a new product or point of view

(ii) Weightage of K – levels in Question Paper

Number of questions for each cognitive level:

Assessment	Cognitive Level	KI			K2			K3			K4, K5, K6			Total
Internal Test	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. Of Questions	1	1			1		1		1	2	1	2	10
External Examination	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. Of Questions	3	-	1	3	1	1	1	2	1	3	2	2	20

Evaluation

i. The performance of a student in each Course is evaluated in terms of percentage of marks with a provision for conversion to grade points.

ii. Evaluation for each Course shall be done by a Continuous Internal Assessment (CIA) by the Course teacher as well as by an end semester examination and will be consolidated at the end of the semester.

iii. There shall be examinations at the end of each semester, for odd semesters in October/November; for even semesters in April / May.

iv. A candidate who does not pass the examination in any course (s) shall be permitted to re-appear in such failed course (s) in the subsequent examination to be held in October / November or April / May. However, candidates who have arrears in Practical Examination(s) shall be permitted to re-appear for their arrears only along with Regular Practical examinations in the respective semester.

iv. Viva- voce: Each candidate shall be required to appear for Viva-voce Examination in defense of the Project.

vi. The results of all the examinations will be published in the College website.

Conferment of the Master's Degree

A candidate shall be eligible for the conferment of the Degree of Master of Arts / Science / Commerce only if the minimum required credits for the programme thereof (91 +10 credits) is earned.

Grading System

For a semester examination:

Calculation of Grade Point Average for End Semester Examination:

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the course}}{\text{Sum of the credits of the courses (passed) in a semester}}$$

For the entire programme:

Cumulative Grade Point Average (CGPA) $\Sigma_n\Sigma_i C_{ni}G_{ni} / \Sigma_{ni}\Sigma_i C_{ni}$

$$CGPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

Where

C_i - Credits earned for course i in any semester

G_i - Grade point obtained for course i in any semester

n - semester in which such courses were credited

Final Result

Conversion of Marks to Grade Points and Letter Grade

Range of Marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-Appear
ABSENT	0.0	AAA	ABSENT

Overall Performance

CGPA	Grade	Classification of Final Results
9.5-10.0	O+	First Class – Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0and above but below 6.5	A	
5.5and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5. 1.0 0	U	Re-appear

*The candidates who have passed in the first appearance and within the prescribed semester are eligible.

SEMESTER – I

CORE COURSE– I: ORGANIC REACTION MECHANISM – I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231CC1	6	1			5	7	105	25	75	100

Pre-requisites:

Students should know the simple reaction mechanisms in Organic Chemistry

Learning Objectives:

1. To understand the mechanism of various organic reactions.
2. To correlate and appreciate the differences involved in the various types of organic reaction mechanisms.
3. To design feasible synthetic routes for the preparation of organic compounds.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	remember & understand the basic concepts of reaction mechanisms, stereochemistry and conformation in organic compounds	**K1 & K2**
2.	apply the reaction mechanism, stereochemistry and conformation for the synthesis of organic compounds	**K3**
3.	analyze the types of reaction mechanisms involved in synthetic organic transformation.	**K4**
4.	evaluate the suitable reaction mechanisms for the synthesis of organic compounds	**K5**
5.	design and synthesize new organic compounds by correlating the stereochemistry of organic compounds.	**K6**

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

Units	Contents	No. of Hours
I	**Methods of Determination of Reaction Mechanism** Reaction intermediates, The transition state, Reaction coordinate diagrams, Thermodynamic and kinetic requirements of reactions: Hammond postulate.Methods of determining mechanism: non-kinetic methods - product analysis, determination of intermediates-isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism.Effect of structure on reactivity: Hammett and Taft equations. Linear free energy relationship, partial rate factor, substituent and reaction constants.	**21**
II	**Aromatic and Aliphatic Electrophilic Substitution** Aromaticity: Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds and annulenes. Aromatic electrophilic substitution: Orientation and reactivity of di- and poly substituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation and arylation reactions.Aliphatic electrophilic substitution Mechanisms: SE2 and SEi, SE1- Mechanism and evidences.	**21**
III	**Aromatic and Aliphatic Nucleophilic Substitution**	**21**

	Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - Reactivity, Effect of structure, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund reactions, von Richter, Sommelet- Hauser and Smiles rearrangements. S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon.S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences, Swain- Scott, Grunwald-Winstein relationship - Ambident nucleophiles.	
IV	**Stereochemistry-I** Introduction to molecular symmetry and chirality – axis, plane, center, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centers. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, chirality due to helical shape, methods of determining the configuration. Racemic modifications: Racemization by thermal, anion, cation, reversible formation, epimerization, mutarotation.D, L system, Cram's and Prelog's rules: R, S-notations, proR, proS, side phase and re phase Cahn-Ingold-Prelog rules, absolute and relative configurations. Configurations of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, exo-cyclic alkylidene-cycloalkanes. Topicity and prostereo isomerism, chiral shift reagents and chiral solvating reagents.Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis.	**21**
V	**Stereochemistry-II** Conformation and reactivity of acyclic systems, intramolecular rearrangements, neighbouring group participation, chemical consequence of conformational equilibrium - Curtin-Hammett Principle.Stability of five and six-membered rings: mono-, di- and polysubstituted cyclohexanes, conformation and reactivity in cyclohexane systems. Fused and bridged rings: bicyclic, poly cyclic systems, decalins and Brett's rule. Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration and conformation, Cotton effect, axial haloketone rule and determination of configuration.	**21**
Self study	Reaction mechanisms and Conformations of simple organic compounds.	

Text Books

1. J.Clayden, N. Greeves, S. Warren, (2014), *Organic Compounds*, 2nd edition, Oxford University Press.
2. F.A. Carey and R.J. Sundberg, (2007), Advanced *Organic Chemistry Part-A and B*, 5th edition, Kluwer Academic / Plenum Publishers.

Reference Books

1. P.S.Kalsi (2015), Stereochemistry of carbon compounds, 8th edition, New Age International Publishers.
2. E. L. Eliel, (2000), Stereochemistry of Carbon Compounds, Tata-McGraw Hill.
3. I. L. Finar (2004), Organic chemistry, Vol-1&2, 6th edition, Pearson Education Asia.

Web Resources

1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2. .https://www.organic-chemistry.org/
3. https://mechanisms.edu.rsc.org

4. https://www.masterorganicchemistry.com/reaction-guide/
5. https://commonorganicchemistry.com/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	3	3	3
CO2	2	3	3	3	3	3	3	2	3	3	3	3
CO3	3	3	2	3	3	3	2	3	3	2	3	3
CO4	2	3	3	3	3	2	3	2	3	3	3	3
CO5	2	3	2	3	3	3	3	2	3	2	3	3
TOTAL	12	15	13	15	14	14	13	12	15	13	15	15
AVERAGE	2.4	3	2.6	3	2.8	2.8	2.6	2.4	3	2.6	3	3

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

CORE COURSE– II: STRUCTURE AND BONDING IN INORGANIC COMPOUNDS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231CC2	7	-	-	-	5	7	105	25	75	100

Pre-requisites:

Students should have elementary knowledge of structure &bonding in inorganic compounds.

Learning Objectives:

1. To determine the structural properties of main group compounds and clusters.
2. To gain fundamental knowledge on the structural aspects of ionic crystals.
3. To familiarize various diffraction and microscopic techniques.
4. To study the effect of point defects and line defects in ionic crystals.
5. To evaluate the structural aspects of solids.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall & understand the structure and bonding in inorganic compounds	**K1 & K2**
2.	apply the concepts of chemical bonding to predict the structure of inorganic compounds	**K3**
3.	analyze the types of bonding, crystal defects and interpret the crystal lattices using diffraction techniques.	**K4**
4.	evaluate bond energy, lattice energy, properties of inorganic compounds	**K5**
5.	create new crystal structures by adopting various crystal growth methods	**K6**

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

Units	Contents	No. of Hours
I	**Structure of main group compounds and clusters** VB theory – Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N and P-N compounds; Poly acids – types, examples and structures; Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure	**21**
II	**Solid state chemistry – I** Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	**21**
III	**Solid state chemistry – II** Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	**21**
IV	**Techniques in solid state chemistry**	**21**

	X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application. Electron microscopy – difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods and applications of SEM and TEM.	
V	**Band theory and defects in solids** Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects due to dislocations.	**21**
Self-study	**Solid state chemistry – I:** Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice	

Text Books

1. D. E. Douglas, D.H. McDaniel and J. J. Alexander, (1994), Concepts and Models in Inorganic Chemistry, 3rd Ed.
2. R J D Tilley, (2013), Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication.
3. C N R Rao and J Gopalakrishnan, (1990), New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press.

Reference Books

1. T. Moeller, (1982), Inorganic Chemistry, A Modern Introduction; John Wiley: New York.
2. D. F. Shriver, P. W. Atkins and C.H. Langford; (2001), Inorganic Chemistry; 3rd ed.; Oxford University Press: London.
3. A R West, (2014), Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd.
4. A K Bhagi and G R Chatwal, (2001), A textbook of inorganic polymers, Himalaya Publishing House.
5. L Smart, E Moore, (2012), Solid State Chemistry – An Introduction, 4th Edition, CRC Press.
6. K. F. Purcell and J. C. Kotz, (1977), Inorganic Chemistry; W.B. Saunders company: Philadelphia.
7. J. E. Huheey, E. A. Keiter and R. L. Keiter, (1983), Inorganic Chemistry; 4th ed.; Harper and Row: New York.

Web Resources

1. https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos/
2. https://hbu.libguides.com/c.php?g=323451&p=2170795
3. https://hbu.libguides.com/chemistry
4. https://en.wikipedia.org/wiki/Metal_cluster_compound
5. https://www2.physics.ox.ac.uk/sites/default/files/BandMT_CompleteSet.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	2	2	2

CO2	3	2	3	3	3	2	3	3	2	2	3	3
CO3	3	3	3	3	3	2	3	3	2	3	2	2
CO4	3	2	3	3	2	3	2	3	3	2	3	2
CO5	3	2	3	3	3	2	2	3	2	2	2	2
TOTAL	15	12	15	15	13	12	12	15	12	11	12	11
AVERAGE	3	2.4	3	3	2.6	2.4	2.4	3	2.4	2.2	2.4	2.2

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

CORE LAB COURSE– I: ORGANIC CHEMISTRY PRACTICAL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231CP1	**-**	**-**	**6**		**4**	**6**	**90**	**25**	**75**	**100**

Pre-requisites:

Students should have a practical knowledge of Organic Chemistry.

Learning Objectives:

1. To understand the concept of separation, qualitative analysis and preparation of organic compounds.
2. To develop analytical skill in the handling of chemical reagents for separation of binary and ternary organic mixtures.
3. To analyze the separated organic components systematically and derivatize them suitably.
4. To construct suitable experimental setup for the organic preparations involving two stages.
5. To experiment different purification and drying techniques for the compound processing.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the methods for the separation and estimation of organic compounds	**K2**
2.	apply the theoretical concepts to identify and synthesize organic compounds	**K3**
3	analyze the elements and functional groups using microscale analysis	**K4**
4	evaluate the quality and quantity of organic compounds	**K5**
5	create organic compounds using various rearrangement reactions	**K6**

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

Units	Contents	No. of Hours
I	**Separation and analysis:** Two component mixtures. Three component mixtures.	**30**
II	**Estimations:** a) Estimation of Ethyl methyl ketone (iodimetry) b) Estimation of Glucose – Bertrand's method c) Estimation of Ascorbic acid (iodimetry) d) Estimation of Glycine (acidimetry) e) Estimation of Formalin (iodimetry) f) Estimation of Acetyl group in ester (alkalimetry) g) Estimation of Hydroxyl group (acetylation) h) Estimation of Amino group (acetylation) i) Estimation of Aromatic nitro groups (reduction)	**30**
III	**Two stage preparations:** a) *p*-Bromoacetanilide from aniline b) *p*-Nitroaniline from acetanilide c) 1,3,5-Tribromobenzene from aniline d) Acetyl salicyclic acid from methyl salicylate e) Benzilic acid from benzoin	**30**

	f) *m*-Nitroaniline from nitrobenzene g) *m*-Nitrobenzoic acid from methyl benzoate	
Self study	General organic preparation and estimation procedures	

Reference Books

1. B.B. Dey, M.V. Sitaraman and T.R. Govindachari, (1992), Laboratory Manual of Organic Chemistry, 2nd Ed., Allied Publishers, New Delhi.
2. A.I. Vogel, (1987), Quantitative Organic Analysis Part III. (2nd Ed.). CBS Publishers, New Delhi.
3. R.K. Bansal, (1990), Laboratory Manual of Organic Chemistry, 2nd Ed., Wiley Eastern Ltd., New York.
4. Furniss, Brian S, Hannaford and Antony J, (**2016)**, Vogel's *Textbook of Practical Organic Chemistry,* 5thEd., Pearson India.
5. Mann & Saunders, **(2009)**, *Practical Organic Chemistry*, Himalaya Publishing House.

Web Resources

1. https://rushim.ru/books/praktikum/Mann.pdf
2. https://fac.ksu.edu.sa/sites/default/files/vogel-practicalorganicchemistry_longmans-3rdedrevised-1957_.pdf
3. https://fac.ksu.edu.sa/sites/default/files/vogel_-_practical_organic_chemistry_5th_edition.pdf
4. https://www.amazon.in/Advanced-Practical-Organic-Chemistry-Vishnoi/dp/8125931287
5. https://www.amazon.in/Practical-Organic-Chemistry-fourth-Saunders/dp/8131727106

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	3	3	3	2	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3	2
CO3	3	3	2	3	3	3	3	2	3	3	2	3
CO4	2	3	3	3	3	2	3	3	3	3	2	3
CO5	2	2	3	3	3	2	3	2	3	2	3	3
TOTAL	12	14	14	15	14	12	15	13	15	13	13	14
AVERAGE	2.4	2.8	2.8	3	2.8	2.4	3	2.6	3	2.6	2.6	2.8

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II: a) NANO MATERIALS AND NANO TECHNOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC1	4	1	-		3	5	75	25	75	100

Pre-requisites

Students should know the basic knowledge of crystallography and material science.

Learning Objectives:

1. To understand the concept of nano materials and nano technology.
2. To understand the various types of nano materials and their properties.
3. To understand the applications of synthetically important nano materials.
4. To correlate the characteristics of various nano materials synthesized by new technologies.
5. To design synthetic routes for synthetically used new nano materials.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the basic concept of nano chemistry and its applications	**K1 & K2**
2.	apply the principle of nanotechnology for the synthesis and characterization of nanomaterials in various fields	**K3**
3.	analyze the physical and chemical properties of nanoparticles	**K4**
4.	evaluate the properties of nanoparticles using various analytical techniques	**K5**
5.	create and characterize novel nanomaterials	**K6**

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

Units	Contents	No. of Hours
I	Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis-Bottom –Up, Top–Down, consolidation of nano powders. Features of nanostructures, Background of nanostructures. Techniques of synthesis of nanomaterials, Tools of the nanoscience. Applications of nanomaterials and technologies.	**15**
II	Bonding and structure of the nanomaterials, Predicting the Type of Bonding in a Substance crystal structure. Metallic nanoparticles, Surfaces of Materials, Nanoparticle Size and Properties. Synthesis-Physical and chemical methods - inert gas condensation, arc discharge, laser ablation, sol-gel, solvothermal and hydrothermal-CVD-types, metallo organic, plasma enhanced, and low-pressure CVD. Microwave assisted and electrochemical synthesis.	**15**
III	Mechanical properties of materials, theories relevant to mechanical properties. Techniques to study mechanical properties of nanomaterials, adhesion and friction, thermal properties of nanomaterials Nanoparticles: gold and silver, metal oxides: silica, iron oxide and alumina–synthesis and properties.	**15**
IV	Electrical properties, Conductivity and Resistivity, Classification of Materials based on Conductivity, magnetic properties, electronic properties of materials. Classification of magnetic phenomena. Semiconductor materials – classification-Ge, Si, GaAs, SiC, GaN, GaP, CdS, PbS. Identification of materials as p and n –type semiconductor-Hall effect - quantum and anomalous, Hall voltage - interpretation of	**15**

	charge carrier density. Applications of semiconductors: p-n junction as transistors and rectifiers, photovoltaic and photogalvanic cell.	
V	Nano thin films, nanocomposites. Application of nanoparticles in different fields. Core-shell nanoparticles-types, synthesis, and properties. Nanocomposites-metal, ceramic and polymer matrix composites-applications. Characterization– SEM, TEM and AFM - principle, instrumentation and applications.	**15**
Self-study	Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis-Bottom –Up, Top–Down.	

Text Books

S.Mohan and V. Arjunan, (2016), Principles of Materials Science, MJP Publishers.

1. Arumugam, (2007), Materials Science, Anuradha Publications.
2. Giacavazzoet. al., (2010), Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications.
3. Woolfson, (2012), An Introduction to Crystallography, Cambridge University Press.
4. James F. Shackelford and Madanapalli K. Muralidhara, (2007), Introduction to Materials Science for Engineers, 6th ed., PEARSON Press.

Reference Books

1. S.Mohan and V. Arjunan, (2016), Principles of Materials Science, MJP Publishers.
2. Arumugam, (2007), Materials Science, Anuradha Publications.
3. Giacavazzoet. al., (2010), Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications.
4. Woolfson, (2012), An Introduction to Crystallography, Cambridge University Press.
5. James F. Shackelford and Madanapalli K. Muralidhara, (2007), Introduction to Materials Science for Engineers, 6th ed., PEARSON Press**.**

Web Resources

1. http://xrayweb.chem.ou.edu/notes/symmetry.html.
2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.
3. https://www.researchgate.net/publication/329505226_Nanomaterials_Sources_Applications_and_Toxicity
4. https://home.iitk.ac.in/~anandh/MSE694/NPTEL_Electrical%20properties%20in%20Nanomaterials.pdf
5. https://iopscience.iop.org/article/10.1088/0022-3727/47/1/013001

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	2	3	3	2	2	2
CO2	3	2	3	3	3	2	3	2	2	3	3	3
CO3	3	3	2	3	2	2	3	3	3	3	3	2
CO4	2	2	3	3	2	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	2	2	2	3
TOTAL	14	12	15	15	12	12	13	14	13	13	13	12
AVERAGE	2.8	2.4	3	3	2.2	2.4	2.6	2.8	2.6	2.6	2.6	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER – I

ELECTIVE COURSE-I : b) PHARMACEUTICAL CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC2	4	1	-	-	3	5	75	25	75	100

Pre-requisites:

Students should have preliminary knowledge about the process of drug delivery.

Learning Objectives:

1. To understand the advanced concepts of pharmaceutical chemistry.
2. To recall the principle and biological functions of various drugs.
3. To train the students to know the importance as well the consequences of various drugs.
4. To have knowledge on the various analysis and techniques.
5. To familiarize on the drug dosage and its structural activities.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the concepts of pharmaceutical chemistry	**K2**
2.	apply the principles of drug action and computers in drug formulation.	**K3**
3.	analyze the drug dosage forms in drug delivery system.	**K4**
4.	evaluate the structure activity relationship in drug formulation.	**K5**
5.	synthesize new drugs after understanding the concepts of SAR.	**K6**

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

Units	Contents	No. of Hours
I	**Physical properties in Pharmaceuticals** Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction. Optical activity\rotation- monochromatic & polychromatic light, optical activity, angle of rotation, specific rotation examples, measurement of optical activity. Dielectric constant & Induced Polarization- Dielectric constant explanation & determination. Rheology of pharmaceutical systems: Introduction, Definition, Applications, concept of viscosity, Newton's law of flow, Kinematic, Relative, Specific, Reduced & Intrinsic viscosity. Newtonian system, non-Newtonian system- Plastic flow, Pseudoplastic flow, Dilatent flow. Viscosity measurements- selection of viscometer for Newtonian and non-Newtonian system.	15
II	**Isotopic Dilution analysis** Principle and applications, Neutron activation analysis: Principle, advantages and limitations, Scintillation counters: Body scanning. Introduction to radiopharmaceuticals. Properties of various types of radiopharmaceuticals, Radiopharmaceuticals as diagnostics, as therapeutics, for research and sterilization. Physico Chemical Properties and drug action. Physico chemical properties of drugs (a) Partition coefficient, (b) solubility (c) surface activity, (d) degree of ionization.	15
III	**Drug dosage and product development** Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias	15

	formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms. Drug dosage and product development. Introduction to drug dosage Forms & Drug Delivery system – Definition of Common terms. Drug Regulation and control, pharmacopoeias formularies, sources of drug, drug nomenclature, routes of administration of drugs products, need for a dosage form, classification of dosage forms.	
IV	**Development of new drugs** Introduction, procedure followed in drug design, the research for lead compounds, molecular modification of lead compounds. Structure-Activity Relationship (SAR): Factors effecting bioactivity, resonance, inductive effect, isoterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory,4.3 Quantitative structure activity relationship (QSAR): Development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, electronic parameter, ionization constants, steric parameters, chelation parameters, redox potential, indicator-variables.	**15**
V	**Computers in Pharmaceutical Chemistry** Need of computers for chemistry. Computers for Analytical Chemists-Introduction to computers: Organization of computers, CPU, Computer memory, I/O devices, information storage, software components. Application of computers in chemistry: Programming in high level language (C^+) to handle various numerical methods in chemistry – least square fit, solution to simultaneous equations, interpolation, extrapolation, data smoothing, numerical differentiation and integrations.	**15**
Self-study	**Physical properties in Pharmaceuticals:** Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction.	

Text Books

1. K.V. Raman, (1993), Computers in chemistry, Tata Mc.Graw-Hill.
2. S.K Pundir, Anshubansal, A pragateprakashan.,Computers for Chemists, 2nd edition, New age international (P) limited, New Delhi.
3. Martins, Patrick J. Sinko, Lippincott. William and Wilkins, Physical Pharmacy and Pharmaceutical Sciences.

Reference Books

1. S.J. Carter,Cooper and Gunn's Tutorial Pharmacy,6th edition by CBS Publisher Ltd.
2. Allen Popvich and Ansel, Ansels pharmaceutical Dosage forms and Drug Delivery System by Indian edition-B.I. Publication Pvt. Ltd.
3. C.V.S. Subramanyam and VallabhPrakashan, Text Book of Physical Pharmaceutics, IInd edition.
4. G.R Chatwal, Medicinal Chemistry (Organic Pharmaceutical Chemistry), Himalaya Publishing house.
5. Hubert H and Willard, Instrumental method of Analysis: 7th edition.
6. Jayshree Ghosh and Dr. S. Lakshmi,Textbook of Pharmaceutical Chemistry, S. Chand &company Ltd., Pharmaceutical Chemistry, Sultan Chand & Sons.

Web Resources

1. https://www.ncbi.nlm.nih.gov/books/NBK482447/
2. https://training.seer.cancer.gov/treatment/chemotherapy/types.html
3. https://www.academia.edu/32351704/Isotope_Dilution_Analysis

4. https://www.slideshare.net/jaymaa/physicochemical-properties-of-drug
5. http://www.jiwaji.edu/pdf/ecourse/pharmaceutical/APPLICATION%20OF%20COMPUTER%20IN%20PHARMACY.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	3	3	2	3	2
CO2	2	3	3	3	3	2	3	3	2	3	3	3
CO3	2	3	2	3	3	2	3	3	3	3	3	2
CO4	3	2	3	3	2	3	2	3	3	3	3	2
CO5	3	3	3	3	3	2	3	3	2	3	2	3
TOTAL	13	14	14	15	13	12	14	15	13	14	14	12
AVERAGE	2.6	2.8	2.8	3	2.6	2.4	2.8	3	2.6	2.8	2.8	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I: C) ANALYTICAL CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC3	4	1	-		3	5	75	25	75	100

Pre-requisites

Students should have the basic knowledge of analytical chemistry.

Learning Objectives:

1. To attain the ability to identify the errors.
2. To understand various analytical techniques.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the principle and instrumentation of various analytical techniques	**K1 & K2**
2.	apply the principle of analytical techniques to predict the purity, stability and concentrations of compounds	**K2 & K4**
3.	analyse chemical compound using various analytical techniques	**K1 & K2**
4.	evaluate the quality and quantity of chemical compounds	**K2 & K3**
5.	understand the principle and instrumentation of various analytical techniques	**K2 & K6**

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

Units	Contents	No. of Hours
I	**Error Analysis** Significant figures - rounding off the values - accuracy and precision. Errors - classification of errors. Expression and calculation of errors in different forms. Precision and accuracy with respect to random errors. Minimization of errors - calibration of apparatus - analysis of standard samples - running a blank determination and independent analysis. Confidence limits. Tests of significance - F-test - t-test - chi square test and annova. Correlation and regression analysis.	**15**
II	**Chromatography** General principle - classification of chromatographic methods - nature of partition forces and chromatographic behaviour of solutes. Plate and rate theories. Normal and reversed phase liquid chromatography. Column chromatography - principle - experimental technique and applications. Gas chromatography - gas-solid and gas-liquid chromatography. Thin layer chromatography - ion exchange chromatography and high performance liquid chromatography.	**15**
III	**Colorimetric and Spectrophotometric Analytical Techniques** Colorimetry - fundamental laws - instrumentation and applications. Spectrophotometry - instrumentation and applications. Principle - instrumentation - applications of fluorimetry - phsophorimetry - flame photometry - nephelometry and turbidimetry. Turbidimetric titrations and applications.	**15**
IV	**Thermoanalytical Techniques** Thermogravimetric analysis (TGA) - principle - instrumentation - factors affecting thermogram - decomposition of calcium oxalate monohydrate and copper sulphate pentahydrate. Differential thermal analysis (DTA) - principle - instrumentation and thermal behaviour of copper sulphate	**15**

	pentahydrate by DTA. Differential scanning calorimetry (DSC) - principle - instrumentation - phase transition studies by DSC. Thermometric titrations - principle - working and applications.	
V	**Electroanalytical Techniques** Electrogravimetric analysis - theory - instrumentation and applications. Coulometric analysis - coulometric titrations and applications. Potentiostatic coulometry. Polarography - principle - current-voltage relationship - dropping mercury electrode (DME) - experimental assembly - polarogram - half-wave potential - Ilkovic equation - applications to qualitative and quantitative analysis. Concept of pulse polarography. Voltametry - principle - cyclic voltametry. Amperometric titrations - principle and applications.	**15**
Self-study	Significant figures - rounding off the values - accuracy and precision. Errors - classification of errors. Expression and calculation of errors in different forms.	

Text Books

1. Kaur, H. (2016). Instrumental Methods of Chemical Analysis. India: Pragati Prakashan Publishing Ltd.
2. Day, R.A. & Underwood, A.L. (1998). Quantitative Analysis. (6th ed.). India: Prentice Hall.

Reference Books

1. Chatwal, G.R. & Anand, S.K. (2002). Instrumental Methods of Chemical Analysis. (5th ed.). India: Himalaya Publishing House.
2. Higson, S. (2003). Analytical Chemistry. (1sted.). USA: Oxford University Press.
3. Christian, G.D. (2007). Analytical Chemistry. (6th ed.). New York: John Wiley & Sons.
4. Skoog, D.A, Holler, F.J & Crouch, S.R (2007). Principles of Instrumental Analysis. (6thed.). Australia: Thompson Brooks/Cole.
5. Gopalan, R., Subramanian, P.S. & Rengarajan, K. (2003). Elements of Analytical Chemistry. (3rded.). New Delhi: Sultan Chand & Sons.

Web Resources

1. https://en.wikipedia.org/wiki/Analytical_chemistry
2. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Analytical_Chemistry_2.1_(Harvey)/01%3A_Introduction_to_Analytical_Chemistry
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5206469/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	2	2	2
CO2	3	2	3	3	3	2	3	2	2	3	3	3
CO3	3	3	2	3	2	2	3	3	3	3	3	2
CO4	2	2	3	3	2	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	2	2	2	3
TOTAL	14	12	15	15	12	12	13	14	13	13	13	12
AVERAGE	2.8	2.4	3	3	2.2	2.4	2.6	2.8	2.6	2.6	2.6	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II : a) ELECTROCHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC4	4	1			3	5	75	25	75	100

Pre-requisites:

Students should know the preliminary aspects of electrochemistry.

Learning Objectives:

1. To understand the behaviour of electrolytes in terms of conductance, ionic atmosphere, interactions.
2. To familiarize the structure of the electrical double layer of different models.
3. To compare electrodes between current density and over potential.
4. To discuss the mechanism of electrochemical reactions.
5. To highlight the different types of over voltages and its applications in electro analytical techniques.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the behaviour of electrolytes in solution.	**K2**
2.	apply Butler-Volmer and Tafel equations to predict the kinetics of electrode reactions	**K3**
3.	analyze the different electrochemical processes	**K4**
4.	evaluate the theories of electrolytes, electrical double layer, electrodics and activity coefficient of electrolytes.	**K5**
5.	design new storage devices using the mechanism of electrochemical reaction	**K6**

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

Units	Contents	No. of Hours
I	**Ionics:** Arrhenius theory -limitations, Van't Hoff factor and its relation to colligative properties. Deviation from ideal behavior. Ionic activity, mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye Huckel theory of strong electrolytes, activity coefficient of strong electrolytes Determination of activity coefficient ion - solvent and ion-ion interactions. Derivation of Debye-Huckel limiting law at appreciable concentration of electrolytes modifications and applications. Electrolytic conduction-Debye-Huckel Onsager treatment of strong electrolyte-qualitative and quantitative verification and limitations.	**15**
II	**Electrode-electrolyte interface:** Interfacial phenomena - Evidences for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electro capillary curves. Electro-kinetic phenomena electro-osmosis, electrophoresis, streaming and sedimentation potentials, colloidal and poly electrolytes. Structure of double layer: Helmholtz -Perrin, Guoy Chapman and Stern models of electrical double layer. Zeta potential and potential at zero charge. Applications and limitations.	**15**
III	**Electrodics of Elementary Electrode Reactions:** Behavior of electrodes: Standard electrodes and electrodes at equilibrium. Anodic and Cathodic	

	currents, condition for the discharge of ions. Nernst 38 equation, polarizable and non-polarizable electrodes. Model of three electrode system, over potential. Rate of electro chemical reactions: Rates of simple elementary reactions. Butler-Volmer equation and Tafel equation-significance of exchange current density, net current density and symmetry factor. Low and high field approximations. symmetry factor and transfer coefficient Tafel equations and Tafel plots.	**15**
IV	**Electrodics of Multistep Multi Electron System:**Rates of multi-step electrode reactions. Rate determining step, electrode polarization and depolarization. Transfer coefficients, its significance and determination, Stoichiometric number. Reduction of I3- , Fe2+ and dissolution of Fe to Fe2+ . Overvoltage - Chemical and electro chemical, Phase, activation and concentration over potentials. Evolution of oxygen and hydrogen at different pH. Pourbiax and Evan's diagrams.	**15**
V	**Concentration Polarization, Batteries and Fuel cells:** Modes of Transport of electro active species - Diffusion, migration and hydrodynamic modes. Role of supporting electrolytes. Polarography principle and applications. Cyclic voltammetry- anodic and cathodic stripping voltammetry and differential pulse voltammetry. Sodium and lithium-ion batteries and redox flow batteries. Energy production systems: Fuel Cells: classification, alkaline fuel cells, phosphoric acid fuel cells, high temperature fuel cells	**15**
Self study	Arrhenius theory -limitations, van't Hoff factor Behaviour of electrodes: Standard electrodes	

Text Books

1. D. R. Crow, (2014), *Principles and applications of electrochemistry*, 4thedition, Chapman& Hall/CRC.
2. J. Rajaram and J.C. Kuriakose, (2011), *Kinetics and Mechanism of chemical transformations*, Macmillan India Ltd., New Delhi.
3. S. Glasstone, (2008), *Electro chemistry*, Affiliated East-West Press, Pvt., Ltd., New Delhi.
4. B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, (2007), *Electrochemistry-Principles and applications*, S. Viswanathan Printers, Chennai.

Reference Books

1. Joseph Wang, (2004), *Analytical Electrochemistry*, 2nd edition, Wiley.

2. Philip H. Rieger, (2010), *Electrochemistry*, 2nd edition, Springer, New York.

3. L.I. Antropov, (1977), *Theoretical electrochemistry*, Mir Publishers.

4. K.L. Kapoor, (2001), *A Text book of Physical chemistry*, volume-3, Macmillan.

5. J.O.M. Bockris and A.K.N. Reddy, (2008),*Modern Electro chemistry*, vol.1 and 2B,
    a. Springer, Plenum Press, New York,.Introduction to plastics, J.H. Brison and C.C.
    b. Gosselin, Newnes, London.
6. J.O.M. Bockris, A.K.N. Reddy and M.G. AldecoMorden, (2008), *Electro chemistry*,
    a. vol. 2A, Springer, Plenum Press, New York,.

Web Resources

1. https://www.pdfdrive.com/modern-electrochemistry-e34333229.
2. https://openlibrary.org/subjects/electrocapillary_phenomena
3. https://en.wikipedia.org/wiki/Butler%E2%80%93Volmer_equation
4. https://www.amrita.edu/course/batteries-and-fuel-cells/

5. https://www.energy.gov/eere/fuelcells/fuel-cells

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	2	2	2
CO2	2	2	2	3	3	2	2	2	3	3	3	3
CO3	3	3	3	2	3	2	3	3	2	3	2	2
CO4	3	3	3	3	2	3	2	2	3	2	3	3
CO5	2	3	2	3	3	2	2	3	3	2	3	2
TOTAL	13	14	13	14	13	12	11	13	14	12	13	12
AVERAGE	2.6	2.8	2.6	2.8	2.6	2.4	2.2	2.6	2.8	2.4	2.6	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II: b) MOLECULAR SPECTROSCOPY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC5	4	1			3	5	75	25	75	100

Pre-requisites:

Students should know the basic knowledge of spectroscopy.

Learning Objectives:

1. To understand the influence of rotation and vibrations on the spectra of the polyatomic molecules.
2. To study the principle of Raman spectroscopy, ESR spectroscopy, EPR spectroscopy and fragmentation patterns in Mass spectroscopy.
3. To highlight the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions.
4. To interpret the first and second order NMR spectra in terms of splitting and coupling patterns using correlation techniques such as COSY, HETCOR, NOESY.
5. To carry out the structural elucidation of molecules using different spectral techniques.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the advanced concepts of spectroscopy.	**K2**
2.	apply the different spectral techniques to elucidate the structure of compounds.	**K3**
3.	analyze the structure of compounds using spectroscopic techniques.	**K4**
4.	evaluate different electronic spectra of simple molecules using electronic spectroscopy.	**K5**
5.	develop the knowledge on principle, instrumentation and structural elucidation of simple molecules using Mass Spectrometry, EPR and Mossbauer Spectroscopy techniques.	**K6**

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

Units	Contents	No. of Hours
I	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules. Intensities of rotational spectral lines, effect of isotopic substitution. Non-rigid rotators. Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, Stokes and anti-Stokes lines. Vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure-O and S branches, Polarization of Raman scattered photons.	**15**
II	**Vibrational Spectroscopy:** Vibrations of molecules, harmonic and anharmonic oscillators-vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect	**15**

	of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-Oppenheimer approximation. Vibrations of polyatomic molecules – symmetry properties, overtone and combination frequencies. Influence of rotation on vibrational spectra of polyatomic molecule, P, Q, R branches, parallel and perpendicular vibrations of linear and symmetric top molecules.	
III	**Electronic spectroscopy:** Electronic Spectroscopy: Electronic spectroscopy of diatomic molecules, Frank-Condon principle, dissociation and predissociation spectra. $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules. Photoelectron Spectroscopy: Basic principles, photoelectron spectra of simple molecules, Xray photoelectron spectroscopy (XPS). Lasers: Laser action, population inversion, properties of laser radiation, examples of simple laser systems.	**15**
IV	**NMR and ESR spectroscopy:** Chemical shift, Factors influencing chemical shifts: electronegativity and electrostatic effects; Mechanism of shielding and deshielding. Spin systems: First order and second order coupling of AB systems, Simplification of complex spectra. Spin-spin interactions: Homonuclear coupling interactions - AX, AX2, AB types. Vicinal, germinal and long-range coupling-spin decoupling. Nuclear Overhauser effect (NOE), Factors influencing coupling constants and Relative intensities. 13CNMR and structural correlations, Satellites. Brief introduction to 2D NMR – COSY, NOESY. Introduction to 31P, 19F NMR. ESR spectroscopy Characteristic features of ESR spectra, line shapes and line widths; ESR spectrometer. The g value and the hyperfine coupling parameter (A), origin of hyperfine interaction. Interpretation of ESR spectra and structure elucidation of organic radicals using ESR spectroscopy; Spin orbit coupling and significance of g-tensors, zero/non-zero field splitting, Kramer's degeneracy, application to transition metal complexes (having one to five unpaired electrons) including biological molecules and inorganic free radicals. ESR spectra of magnetically dilute samples.	**15**
V	**Mass Spectrometry, EPR and Mossbauer Spectroscopy:** Ionization techniques- Electron ionization (EI), chemical ionization (CI), desorption ionization (FAB/MALDI), electrospray ionization (ESI), isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution. Effect of isotopes on the appearance of mass spectrum. EPR spectra of anisotropic systems - anisotropy in g-value, causes of anisotropy, anisotropy in hyperfine coupling, hyperfine splitting caused by quadrupole nuclei. Zero-field splitting (ZFS) and Kramer's degeneracy. Applications of EPR to organic and inorganic systems. Structural elucidation of organic compounds by combined spectral techniques. Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.	**15**
Self	Electronic transitions, NMR introduction	

study	

Text Books

1. C. N. Banwell and E. M. McCash (2000), *Fundamentals of Molecular Spectroscopy*, 4th Ed., Tata McGraw Hill, New Delhi.
2. R. M. Silverstein and F. X. Webster(2003), *Spectroscopic Identification of Organic Compounds*, 6th Ed., John Wiley & Sons, New York.
3. W. Kemp(1987), *Applications of Spectroscopy*, English Language Book Society.
4. D. H. Williams and I. Fleming (1988), *Spectroscopic Methods in Organic Chemistry*, 4th Ed., Tata McGraw-Hill Publishing Company, New Delhi.

Reference Books

1. R. S. Drago(1992), *Physical Methods in Chemistry*; Saunders: Philadelphia.
2. P.W. Atkins and J. de Paula(2002), *Physical Chemistry*, 7th Ed., Oxford University Press, Oxford,.
3. I. N. Levine(1974), *Molecular Spectroscopy*, John Wiley & Sons, New York.
4. A. Rahman(1986), *Nuclear Magnetic Resonance-Basic Principles*, Springer-Verlag, New York,.
5. K. Nakamoto (1997), *Infrared and Raman Spectra of Inorganic and coordination Compounds*,
6. PartB: 5th ed., John Wiley& Sons Inc., New York.
7. J. A. Weil, J. R. Bolton and J. E. Wertz (1994), *Electron Paramagnetic Resonance*; Wiley Interscience,

Web Resources

1. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
2. https://www.digimat.in/nptel/courses/video/104106122/L14.html
3. https://www.coursera.org/learn/spectroscopy
4. https://www.thermofisher.com/in/en/home/industrial/spectroscopy-elemental-isotope-analysis/molecular-spectroscopy.html
5. https://www.wiley.com/en-us/Computational+Molecular+Spectroscopy-p-9780471489986

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	2	2	2
CO2	2	2	2	3	3	3	2	3	3	3	3	3
CO3	3	3	2	2	3	2	3	3	2	3	3	2
CO4	3	3	3	3	2	3	2	2	2	2	3	3
CO5	3	3	2	3	3	2	2	3	3	2	3	2
TOTAL	14	14	12	14	13	13	11	14	13	12	14	12
AVERAGE	2.8	2.8	2.4	2.8	2.6	2.6	2.2	2.8	2.6	2.4	2.8	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER I
ELECTIVE COURSE II: c) INDUSTRIAL PRODUCTS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231EC6	4	1	-		3	5	75	25	75	100

Pre-requisites

Students should have the basic knowledge of industrial products.

Learning Objectives:

1. To attain the ability to identify the errors.
2. To understand various analytical techniques.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the manufacturing processes of cement and glass.	**K1 & K2**
2.	apply different methods for manufacturing industrial products	**K3**
3.	analyze the types of dyes, pigments and paints.	**K4**
4.	evaluate the composition versus quality of industrial products	**K5**
5.	Synthesize new industrial products	**K6**

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

Units	Contents	No. of Hours
I	**Cement and Glass** Cement - Composition, different methods of manufacturing and uses - Portland cement - Composition, different methods of manufacturing (Wet and Dry process), uses - Setting of cement, Glass- - Composition, Types, different methods of manufacturing - Melting, Blowing, Pressing, Annealing and finishing- chemical and physical properties of glass.	**15**
II	**Pigments, Dyes and Paints** Pigments - Classification, Manufacture and uses. Dyes - Classification, preparation, dyeing processes. Paints - Composition, Types, Manufacture and testing of Paints.	**15**
III	**Fibres, Plastics and Rubber** Fibres - definition-difference between Natural and synthetic fibres-properties of synthetic fibres-Artificial silk, rayon, nylon and Terylene Plastics - composition, Classification, manufacture, properties and uses recycling of plastics Rubber: types of rubber-synthetic rubber- natural rubber - Vulcanizations of Rubber- properties and uses of rubber.	**15**
IV	**Fertilizers and Fuels** Fertilizers -Types of Fertilizers: Organic and Inorganic fertilizers, Preparation and uses, Fuels - Energy resources - Industrial gases, Water gas, Producer gas, Oil gas, natural gas, coal gas, Gobar gas, Indane gas, Petroleum products and coal products.	**15**
V	**Cosmetics** Shampoo- composition and its preparation, lipstick -preparation, Face cream and face powder -composition and their preparation. Hair dyes - chemical and herbal dyes. Perfumes and Deodorants.	**15**

Self-study	Pigments - Classification, Manufacture and uses. Dyes - Classification, preparation, dyeing processes.	

Text Book

1. Charkarabarthy B N, *Industrial Chemistry*, Oxford and IBH Publishing. Co. 1st Edition. New Delhi, 2002.

Reference Books

1. Sharma B K, *Industrial Chemistry*, Goel Publishing House, 1st Edition, New Delhi, 2011.
2. Othmer K, *Encyclopedia of Chemical Technology*, John Wiley and Sons,USA, 1999.

Web Resources

1. https://www.safecosmetics.org/chemicals/
2. https://www.theartconnect.in/collections/other-cosmetic-chemicals

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	2	3	3	2	2	2
CO2	3	2	3	3	3	2	3	2	2	3	3	3
CO3	3	3	2	3	2	2	3	3	3	3	3	2
CO4	2	2	3	3	2	3	2	3	3	3	3	2
CO5	3	2	3	3	3	2	3	3	2	2	2	3
TOTAL	14	12	15	15	12	12	13	14	13	13	13	12
AVERAGE	2.8	2.4	3	3	2.2	2.4	2.6	2.8	2.6	2.6	2.6	2.4

3 – Strong, 2- Medium, 1- Low

SEMESTER I

SPECIFIC VALUE ADDED COURSE

HERBAL PRODUCT DEVELOPMENT AND FORMULATION

Course Code	Credits	Total Hours	Total Marks
CP231V01	1	30	100

Learning Objectives

1. To understand the indigenous tradition of herbal medicinal practice and to impart awareness regarding the vitality of herbal product development
2. To train the students to develop entrepreneurial skill in herbal product production and marketing
3. To familiarize the medicinal uses to herbals and to scientifically validate and standardize crude drugs.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the role of natural products in herbal medicines.	**K1 & K2**
2	apply the extraction techniques in herbal drug formulation.	**K3**
3	analyse crude drugs and herbal formulation to determine their quality.	**K4**
4	evaluate crude drugs and herbal formulations as per the WHO and cGMP guidelines and stability testing of herbal drugs.	**K5**
5	synthesize herbal products.	**K6**

Unit-I

Introduction to Herbs and Herbal Medicines

Importance of Herbs in human life - Medicinal properties of Herbal plants - Chronic diseases and Herbs - Traditional medicines and its worldwide applications . Herbal Based industry: Scope, study of infrastructure, staff requirements, project profiles, equipment, processing, regulatory requirements, research and development. Role of natural products in herbal medicines. General status and importance of herbal medicines in the chronic diseases. Safety of herbals/herbal pharmacovigilance. W.H.O Policy on herbal medicines.

Unit-II

Definition of herb, herbal extraction, herbal medicines and herbal drug preparations - Process of phytochemical/Bioactive compounds extraction and isolation - Extraction techniques - Maceration, Percolation, Soxhlet, etc - Isolation of potential bioactive compounds through TLC, column chromatography and prep-HPLC techniques. Preparation of Kuzhi Thailam, Kashayam, Suranam, etc. - Synthetic approach for the identified active compounds to ease the cost effective herbal drug product availability. Source, selection, identification and authentication of herbal materials - Drying and processing of herbal raw materials. Packing and labelling of finished products.

Unit-III

Standardization of Herbal Extracts as per WHO/cGMP Guidelines

Physical, chemical, spectral and toxicological standardization - Chromatographic and Spectrometric - Qualitative and quantitative estimations exemplified by the methods of preparation of at least two standardized extracts. Stability studies for the different types of

extracts and its secondary metabolites. Predictable chemical and galenical changes. Structure based Drug Design Approach: Enhancement of bioactivity through structural modification on the identified phytoconstituents - Isomeric compounds and its specificity in bioactivity.

Unit-IV

Herbal Product Development

Preparation of liquid orals, tablets, capsules, ointments, creams and cosmetics Methods involved in monoherbal and polyherbal formulation with their merits and demerits. Excipients used in herbal formulation - Synergistic effects of combined Herbal medicines. Study of Drugability: Compatibility studies, Stability studies, Bioavailability and Pharmacokinetic aspects for herbal drugs with examples of well-known documented and clinically used herbal drugs - Drugability comparison with the existing standard drugs. Quality Control of finished herbal medicinal products.

Unit-V

Screening of Natural Products for the Following Biological Activities

Method for the identification and screening of potential bioactive compounds through TLC, HPLC, GC and Mass Spectrometry. Thermal stability of secondary metabolites present in the Herbal plants during the initial screening - Identification of Active Principals, Examples of any five bioactive compounds and their medicinal uses. Screening of natural products for the following biological activities (a) Antidiabetic (b) Anticancer (c) Antihypertensive (d) Antiarrhythmics (e) Antipyretics (f) Antioxidants (g) Antibacterial (h)Antifungal (i) Antiepileptic (j) Osteoporosis (k) Nephroprotective (l) Immunomodulators (m) Alzheimers (n) Antifertility

Text Books

1. Trease, G.E. and Evans, W.C (1989), Pharmacognosy. 13th Edition, Baillière Tindall, London,.
2. Wallis T.E (2005)., Textbook of Pharmacognosy, 5th Edition, New Delhi: CBS.
3. AC Moffat (1986), Clarke's Isolation and Identification of Drugs. 2nd ed. The Pharmaceutical Press.
4. C.K. Kokate, Purohit, Ghokhale(1996), Text book of Pharmacognosy 5th edn, Nirali Prakassan.
5. Harborne .B(1973)., Phytochemical Methods. Chapman and Hall Ltd., London,.

References

1. A.A. Farooqui and B.S. Shreeramu (2001), Cultivation of medicinal and aromatic crops, 1st edn, University press.
2. S.N. Yoganarasimhan(2000), Medicinal plants of India, 1st edn, Interline publication Pvt. Ltd.
3. Paul M. Dewick (1998), Medicinal natural products (a biosynthetic approach), 1st edn, John Wiley and sons Ltd., England.
4. Peter B. Kaufman(1998), Natural Products from plants, 1st edn, CRC press, New York.

SEMESTER II

CORE COURSE III: ORGANIC REACTION MECHANISM – II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite

Students should know the types of reactions and reagents in Organic Chemistry

Learning Objectives.

1. To understand the mechanism involved in various types of organic reactions with evidences.
2. To correlate the reactivity between aliphatic and aromatic compounds.
3. To design synthetic routes for synthetically used organic reactions.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	remember the basic principles of organic compounds.	**K1**
2.	understand the mechanism of various types of organic reactions.	**K2**
3.	apply the suitable reagents for the conversion of selective organic compounds.	**K3**
4.	analyze the principles of substitution, elimination, and addition reactions.	**K4**
5.	evaluate the reaction mechanisms and design new routes to synthesis of organic compounds.	**K5 &K6**

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

Units	Contents	No. of Hours
I	**Elimination and Free Radical Reactions:** Mechanisms: E_2, E_1, and E_{1CB} mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Effect of substrate, solvent, attacking bases and leaving group. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Free radicals - detection and stability of radicals. Free radical reactions - characteristics of free radical reactions - polymerization, addition, halogenations, aromatic substitutions, rearrangements. Free radical reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.	**18**
II	**Oxidation and Reduction Reactions:** Mechanism of oxidation reactions-dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate, lead tetraacetate, osmium tetroxide, Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD). Mechanism of reduction reactions- Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.	**18**
III	**Molecular Rearrangements:** Molecular rearrangements- classification-electrophilic- nucleophilic and free radical rearrangements. Mechanisms of Wagner-Meerwein, Tiffenev-Demjanov, Dienone-phenol, Baker-Venkataraman, Baeyer-Villiger oxidation, Neber, Sommelet-Hauser, Von-Ritcher, Ullmann, Pummerer, Di-πmethane and Dakin rearrangements- Favorskii, Quasi-Favorskii, Stevens, Fries and Photo Fries rearrangement. Intramolecular rearrangements – Claisen, Cope, oxy-Cope rearrangements.	**18**
IV	**Addition to Carbon Multiple Bonds:** Addition to carbon-carbon multiple bonds-Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and	**18**

	cyclic mechanisms. Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, Wittig reaction. Addition of Grignard reagents- organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates - Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.	
V	**Reagents and Modern Synthetic Reactions:** Lithium diisopropylamine (LDA) - Sodium cyanoborohydride ($NaBH_3CN$) - meta-Chloroperbenzoic acid (m-CPBA)- Dimethyl aminiopyridine (DMAP)-n-Bu_3SnH- Triethylamine (TEA)-Diethylazo dicarboxylate (DEAD)- N-bromosuccinimide (NBS)-Trifluoroacetic acid (TFA)- Phenyltrimethyl ammonium tribromide (PTAB)-Diazomethane and Zn-Cu. Diethyl maleate (DEM)-Copper diacetyl acetonate ($Cu(acac)_2$)- $TiCl_3$-$NaIO_4$-Pyridinium chlorochromate (PCC)-Pyridinium dichromate (PDC)-Suzuki coupling-Heck reaction- Negishi reaction-Baylis-Hillman reaction.	**18**

Self-study	General reaction mechanisms and Reagents in Organic chemistry.

Textbooks

1. J. March and M. Smith, 2001. Advanced Organic Chemistry, 5th ed., John-Wiley and Sons..
2. P. S. Kalsi, 2015. Stereochemistry of carbon compounds, 8thedn, New Age International Publishers,
3. P. Y.Bruice, 2013. Organic Chemistry, 7thedn.,Prentice Hall,
4. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 2010.Organic Chemistry, 7thedn., Pearson Education,

Reference Books

1. S. H. Pine, *Organic Chemistry*, 1987. 5thedn, McGraw Hill International Edition.
2. L. F. Fieser and M. Fieser, 2000. *Organic Chemistry*, Asia Publishing House, Bombay.
3. E.S. Gould, 1959. *Mechanism and Structure in Organic Chemistry*, Holt, Rinehart and Winston Inc.
4. T. L. Gilchrist, 1989. *Heterocyclic Chemistry*, Longman Press.
5. J. A. Joule and K. Mills, 2010. *Heterocyclic Chemistry*, 4thed., John-Wiley.

Web Resources

1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2. https://www.organic-chemistry.org/
3. https://mechanisms.edu.rsc.org
4. https://www.masterorganicchemistry.com/reaction-guide/
5. https://commonorganicchemistry.com/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	3	3	2	3	3
CO2	2	3	3	3	3	2	3	3	3	3	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2
CO4	2	3	3	3	3	2	3	3	3	3	3	2
CO5	2	3	3	3	3	2	3	2	3	3	3	3
TOTAL	12	15	14	15	14	12	15	13	15	14	15	13
AVERAGE	2.4	3.0	2.8	3.0	2.8	2.4	3.0	2.6	3.0	2.8	3.0	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE IV - PHYSICAL CHEMISTRY – I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232CC2	6				5	6	90	25	75	100

Pre-requisites:

Students should understand the basic concepts of rate of reactions and thermodynamics.

Learning Objectives:

1. To recall the fundamentals of thermodynamics and the composition of partial molar quantities.
2. To study the mechanism and kinetics of reactions.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall the basic concepts of thermodynamics.	**K1**
2.	understand the classical and statistical concepts of thermodynamics.	**K2**
3.	apply the thermodynamic concepts to study the kinetics of chemical reactions.	**K3**
4.	analyze the thermodynamics for real gases ad mixtures.	**K4**
5.	evaluate the various kinetic methods of chemical reactions.	**K5**

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

Units	Contents	No. of Hours
I	**Classical Thermodynamics** Partial molar properties-Chemical potential, Gibb's-Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity-determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation, applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states -determination-vapour pressure, EMF and freezing point methods.	**18**
II	**Statistical thermodynamics** Introduction of statistical thermodynamics, concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell - Boltzmann, Fermi Dirac & Bose-Einstein Statistics- comparison and applications. Partition functions-evaluation of translational, vibrational and rotational partition functions for mono atomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions-calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function residual entropy, equilibrium constants and equipartition principle. Heat capacity of mono and diatomic gases-ortho and para hydrogen. Heat capacity of solids-Einstein and Debye models.	**18**
III	**Irreversible Thermodynamics** Theories of conservation of mass and energy entropy production in open	

	systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems.	**18**
IV	**Kinetics of Reactions** Theories of reaction rates-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindeman and Christiansen hypothesis- Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules. Factors determining the reaction rates in solution - primary salt effect and secondary salt effect, Homogeneous catalysis- acid-base catalysis-mechanism of acid base catalyzed reactions-Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.	**18**
V	**Kinetics of complex and fast reactions** Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of $H_2 - Cl_2$ & $H_2 - Br_2$ reactions (Thermal and Photochemical reactions) - Rice Herzfeld mechanism. Study of fast reactions-relaxation methods- temperature and pressure jump methods electric and magnetic field jump methods -stopped flow flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization - Poly condensation.	**18**

Self study	Partial molar properties-Chemical potential, Gibb's-Duhem equation Theories of conservation of mass and energy entropy production in open systems by heat, matter

Text Books

1. Rajaram and J.C. Kuriacose, 1986. *Thermodynamics for Students of Chemistry*, 2nd edition,S.L.N.Chand and Co., Jalandhar,
2. I.M. Klotz and R.M. Rosenberg, 1972. *Chemical thermodynamics*, 6th edition, W.A.BenjaminPublishers, California.
3. M.C. Gupta, 1995. *Statistical Thermodynamics*, New Age International, Pvt. Ltd., New Delhi.
4. K.J. Laidler, 2013. *Chemical Kinetics*, 3rd edition, Pearson, Reprint.

Reference Books

1. J. Rajaram and J.C. Kuriokose, 2011. *Kinetics and Mechanisms of chemical transformation* ,Macmillan India Ltd, Reprint.
2. K.B. Ytsiimiriski, 1996. "*Kinetic Methods of Analysis*", Pergamom Press.
3. Gurdeep Raj, 2011. Phase rule, Goel Publishing House
4. D.A. Mcqurrie And J.D. Simon, 1999. *Physical Chemistry - A Molecular Approach*, Viva Books Pvt. Ltd., New Delhi.
5. R.P. Rastogi and R.R. Misra, 1990. *Classical Thermodynamics*, Vikas Publishing, Pvt. Ltd., New Delhi.
6. S.H. Maron and J.B. Lando,1974. *Fundamentals of Physical Chemistry*, Macmillan Publishers, New York.

Web Resources

1. https://nptel.ac.in/courses/104/103/104103112/
2. https://bit.ly/3tL3GdN
3. https://books.google.co.in/books?id=8N38DwAAQBAJ&pg=PT16&dq=web+resources+classical+mechanics&hl=en&newbks=1&newbks_redir=1&sa=X&ved=2ahUKEwj53fCA-JT_AhUZ2TgGHVJ0CjcQ6AF6BAgGEAI
4. https://phet.colorado.edu/en/simulation/reactions-and-rates

5. https://pubs.acs.org/doi/10.1021/ja408723a

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	3	3	3	3	3	2	2
CO2	3	2	2	3	3	2	3	3	2	2	3	3
CO3	3	3	2	3	2	3	3	3	2	3	2	2
CO4	3	3	3	2	2	3	2	3	3	3	3	3
CO5	3	2	3	3	3	2	3	2	2	2	2	3
TOTAL	15	13	12	14	12	13	14	14	12	13	12	13
AVERAGE	3	2.6	2.4	2.8	2.4	2.6	2.8	2.8	2.4	2.6	2.4	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE LAB COURSE II: INORGANIC CHEMISTRY PRACTICAL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232CP1	-	-	6	-	4	6	90	25	75	100

Pre-requisite

Basic principles of gravimetric and qualitative analysis

Learning Objectives

1. To analyze cations from a given mixture.
2. To estimate metal ions, present in the given solution accurately without using instruments.
3. To determine the amount of ions, present in a binary mixture accurately

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall & understand the basic principles in the analysis of cations from a given mixture	**K1 & K2**
2.	apply the principles of semi micro qualitative analysis to categorize the cations	**K3**
3.	analyze the cations by selecting suitable confirmatory tests and spot tests.	**K4**
4.	evaluate the amount of ions present in a binary mixture using complexometric titrations	**K5**
5.	synthesize coordination compounds using appropriate ligands and metal ions.	**K6**

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

Units	Contents	No. of Hours
I	**Analysis of mixture of cations:** Analysis of a mixture of four cations containing two common cations and two rare cations.Cations to be tested. Group-I : W, Tl and Pb. Group-II : Se, Te, Mo, Cu, Bi and Cd. Group-III : Tl, Ce, Th, Zr, V, Cr, Fe, Ti and U. Group-IV : Zn, Ni, Co and Mn. Group-V : Ca, Ba and Sr. Group-VI : Li and Mg.	**30**
II	**UNIT-II: Preparation of metal complexes:** Preparation of inorganic complexes: a. Preparation of tristhiourea copper(I)sulphate b. Preparation of potassium trioxalate chromate (III) c. Preparation of tetrammine copper(II) sulphate d. Preparation of Reineck's salt e. Preparation of hexa thiourea copper(I) chloride dihydrate f. Preparation of *cis*-Potassium tri oxalate diaqua chromate(III) g. Preparation of sodium trioxalatoferrate(III) h. Preparation of hexa thiourea lead(II) nitrate	**30**
III	**UNIT-III: Complexometric Titration:** 1. Estimation of zinc, nickel, magnesium, and calcium. 2. Estimation of mixture of metal ions-pH control, masking and demasking agents.	**30**

	3. Determination of calcium and lead in a mixture (pH control). 4. Determination of manganese in the presence of iron. 5. Determination of nickel in the presence of iron.	

Textbooks

1. V. V. Ramanujam,1974. *Inorganic Semimicro Qualitative Analysis*; 3rded., The National Publishing Company, Chennai.
2. Vogel,1979. *Vogel's Text book of Inorganic Qualitative Analysis,* 4thed., ELBS, London.

Reference Books

1. JeyaRajendran,2021. *Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis*, United global publishers.
2. G. Pass, and H. Sutcliffe, 1965. *Practical Inorganic Chemistry*; Chapman Hall.
3. W. G. Palmer,1954. Experimental *Inorganic Chemistry*; Cambridge University Press.
4. Shikha Gulati,2019. *Practical Inorganic Chemistry*,CBS Publishers and Distributors Pvt Ltd.
5. O. J. Vorobyova, K. M. Dunaeva; E. A. Ippolitova; N. S. Tamm; V. I. Spitsyn,1984. *Practical Inorganic Chemistry*,MIR Publishers, Mascow.

Web Resources

1. https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXII/chemistry/lelm107.pdf
2. **https://iscnagpur.ac.in/study_material/dept_chemistry/4.1_MIS_and_NJS_Manual_for_Inorganic_semi-micro_qualitative_analysis.pdf**
3. https://www.cambridge.org/9781316509838
4. https://pubmed.ncbi.nlm.nih.gov/5707622/
5. https://vlab.amrita.edu/index.php?sub=2&brch=193

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	3	3	3	2	3	3	3	3	3	3	3
CO2	2	**3**	**3**	**3**	**3**	**2**	**3**	3	3	3	3	3
CO3	3	**3**	**2**	**3**	**3**	**3**	**2**	3	3	3	3	3
CO4	2	**3**	**3**	**3**	**3**	**2**	**3**	3	3	3	3	3
CO5	2	**3**	**2**	**3**	**3**	**2**	**3**	3	3	3	3	3
TOTAL	12	15	13	15	14	12	15	15	15	15	15	15
AVERAGE	2.4	3.0	2.6	3.0	2.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: a) MEDICINAL CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite

Basic knowledge of medicinal chemistry

Learning Objectives

1. To study the chemistry behind the development of pharmaceutical drugs.
2. To gain knowledge on mechanism and action of drugs.
3. To identify and apply the action of various antibiotics.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understandthe drug properties based on its structure.	**K2**
2.	apply the relationship between drug's chemical structure and its therapeutic properties.	**K3**
3.	analyze the factors that affect the absorption, distribution, metabolism, and excretion in drug design.	**K4**
4.	evaluate the different theories of drug actions at molecular level.	**K5**
5.	design new drugs for the treatment of various diseases.	**K6**

K1 - Remember; **K2** - Understand; **K3** - Apply

Units	Contents	No. of Hours
I	**Classification and Nomenclature of Drugs** Important terminologies - Molecular Pharmacology, pharmacophore, metabolites, antimetabolites, virus, bacteria, fungi, actinomycetes, mutation. Classification of drug. Nomenclature of drugs – non-proprietary names – source, assay (biological, chemical, immunological). Testing of potential of drugs and their side effects.	**12**
II	**Antibiotics:** Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicillin and tetracycline, clinical application of penicillin, cephalosporin. Current trends in antibiotic therapy.	**12**
III	**Antihypertensive agents and diuretics:** Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, Amiloride.	**12**
IV	**Antipyretics and Anti-diabetic Drugs:** Introduction, Mechanism of inflammation, classification and mechanism of action - paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone and meperidine. Medicinal Chemistry of Antidiabetic agents- Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action – insulin and sulfonyl urea.	**12**
V	**Role of Metals in Drugs:** Mechanism of drug action - absorption, drug delivery, drug excretion. Physiological effects of different functional groups in drugs. antineoplastic agents - Cobalt therapy . Biological role of salts of Na, K, and Ca, Cu, Zn. Uses of $MgSO_4.7H_2O$, milk of magnesia,	**12**

	magnesium trisilicate, aluminium hydroxide gel, $HgCl_2$, HgI_2 and $Hg(CN)_2$ as disinfectants.	

Self-study	Introduction, targets, agonist, antagonist, partial agonist.

Textbooks

1. Wilson, Charles Owens, Beale, John Marlowe, Block, John H, Lipincott William, 2011. *Organic Medicinal and Pharmaceutical Chemistry,* 12th edition,Library of Congress Cataloging-in-Publication Data.
2. JayashreeGhosh,1999. *A textbook of Pharmaceutical Chemistry*,1999. edn. S.Chand and Co. Ltd.
3. O.LeRoy,1976. *Natural and synthetic organic medicinal compounds* , Ealemi.
4. S. AshutoshKar,1993. *Medicinal Chemistry*, 4thedn, Wiley Eastern Limited, NewDelhi.

Reference Books

1. Lipincott Williams, 2012. *Foye's Principles of Medicinal Chemistry,* Seventh Edition ,Lippincott Williams & Wilkins.
2. Donald J. Abraham, David P. Rotella, Alfred Burger, 2010. .*Burger's Medicinal Chemistry, Drug Discovery and Development*, Academic press,
3. Graham L. Patrick,2013. *An Introduction to Medicinal Chemistry*, 5th edition, Oxford University Press.
4. P.Parimoo,1995. *A Textbook of Medical Chemistry* ,NewDelhi:CBSPublishers.
5. S.Ramakrishnan,K.G.PrasannanandR.Rajan,2001.*TextbookofMedicalBiochemistry*,3rd edition, Hyderabad: Orient Longman.

Web Resources

1. https://www.ncbi.nlm.nih.gov/books/NBK482447/
2. https://training.seer.cancer.gov/treatment/chemotherapy/types.html
3. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908
4. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD008161.pub3/full
5. https://www.sciencedirect.com/topics/medicine-and-dentistry/antipyretic-analgesic-agent

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	3	3	3	2	3	3	3	3	3	3	3
CO2	2	**3**	**3**	**3**	**3**	**2**	**3**	3	3	3	3	3
CO3	3	**3**	**2**	**3**	**3**	**3**	**2**	3	3	3	3	3
CO4	2	**3**	**3**	**3**	**3**	**2**	**3**	3	3	3	3	3
CO5	2	**3**	**2**	**3**	**3**	**2**	**3**	3	3	3	3	3
TOTAL	12	15	13	15	14	12	15	15	15	15	15	15
AVERAGE	2.4	3.0	2.6	3.0	2.8	2.4	3.0	3.0	3.0	3.0	3.0	3.0

3 – Strong, 2- Medium, 1- Low

SEMESTER II
ELECTIVE COURSE III: b) GREEN CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC2	3	1	-	-	3	4	60	25	75	100

Pre-requisites:

Students should know the basic principles of green chemistry and methods to prevent pollution.

Learning Objectives:

1. To emphasize pollution prevention in industrial, chemical, fuel production, automotive industry and shipping industries.
2. To provide green solutions for chemical energy storage and conversion.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall the basic chemical techniques used in conventional industrial preparations and in green innovations.	**K1**
2.	understand the various techniques used in chemical industries and in laboratory	**K2**
3.	apply the principles of PTC, ionic liquid, microwave and ultrasonic assisted organic synthesis.	**K3**
4.	analyze the advantages of organic reactions assisted by renewable energy sources and non-renewable energy sources.	**K4**
5.	evaluate, design and synthesize new organic compounds by green methods.	**K5 & K6**

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

Units	Contents	No. of Hours
I	Introduction- Need for Green Chemistry. Goals of Green Chemistry. Limitations/ of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and Twelve principles of Green Chemistry with examples.	**12**
II	Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis-green reagents: dimethyl carbonate. Green solvents: Water,Ionic liquids-criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in CO_2. Green synthesis-adipic acid and catechol.	**12**
III	Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts-Poly styrene aluminum chloride, polymeric super acid catalysts, Poly supported photosensitizers.	**12**
IV	Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis	**12**

V	Micro wave induced green synthesis-Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.	**12**

Self study	Principles of green chemistry

Text Books

1. Anastas, P.T. and Warner, J.K 1998. *Oxford Green Chemistry -Theory and Practical*, University Press.
2. Matlack, A.S, 2001. *Introduction to Green Chemistry*, Marcel Dekker.
3. Cann, M.C. and Connely, M.E, 2000. *Real-World Cases in Green Chemistry*, American Chemical Society, Washington.
4. Ryan, M.A. and Tinnesand, M, 2002. *Introduction to Green Chemistry*, American Chemical Society Washington

Reference Books

1. Chandrakanta Bandyopadhyay, 2019. An Insight into Green Chemistry, Books and Allied (P) Ltd,
2. Ahluwalia, V.K. and Kidwai, M.R., 2005. *New Trends in Green Chemistry*, Anamalaya Publishers
3. K. De, 2017. ,*Environmental Chemistry*, New Age Publications.
4. V. K. Ahluwalia and R. Aggarwal 2001. *Organic Synthesis: Special Techniques*, Narosa Publishing House, New Delhi.
5. J. M. Swan and D. St. C. Black 1974. *Organometallics in Organic Synthesis*, Chapman Hall.

.**Web Resources**

1. https://www.organic-chemistry.org/
2. https://www.studyorgo.com/summary.php
3. https://www.epa.gov/greenchemistry/green-chemistry-resources
4. https://www.acs.org/greenchemistry.html
5. https://ecology.wa.gov/Waste-Toxics/Reducing-toxic-chemicals/Green-chemistry/Green-chemistry-for-K-12-classroom

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	3	3	3	3	3	3
CO2	2	3	3	2	3	2	2	3	3	2	3	2
CO3	3	2	2	2	3	3	3	2	3	3	2	2
CO4	2	3	3	3	2	2	2	3	2	3	3	3
CO5	3	3	3	3	3	3	3	2	3	3	2	3
TOTAL	13	14	14	13	13	13	13	13	14	14	13	13
AVERAGE	2.6	2.8	2.8	2.6	2.6	2.6	2.6	2.6	2.8	2.8	2.6	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER II
ELECTIVE COURSE III: c) TRANSITION METAL CHEMISTRY

CourseCode	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC3	**3**	**1**	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisites:

Students should know the transition series and their general properties.

Learning Objectives:

1. To understand the characteristics and reaction mechanisms of transition metals.
2. To study the importance of transition metals as effective catalysts.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall the general characteristics and understand the reaction mechanisms of transition metal compounds.	**K1&K2**
2.	apply the reaction mechanisms in the synthesis of complexes.	**K2**
3.	analyze the various types of reactions involved in transition metal complexes	**K3**
4.	evaluate the various parameters involved in the spectra of transition metal complexes	**K4**
5.	design new routes for the synthesis of organometallic compounds	**K5 & K6**

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

Units	Contents	No. of Hours
I	Second and third transition series: Zirconium and Hafnium - Occurrence, isolation and oxidation states. Aqueous Chemistry - Zr^{4+} and Hf^{4+} halides, ZrO_2 and mixed oxides, Zr clusters. Niobium and Tantalum - Occurrence, isolation, oxidation states, oxygen compounds and pentafluoride. Rhenium- Occurrence, isolation and oxidation states. Preparation and properties of Rhenium heptafluoride, $ReCl_5$, $ReCl_4$ and $ReCl_3$. General characteristics of Ruthenium and Osmium: Nitrogen-ligand complexes of Ru. Creutz- Taube and related complexes - Rh and Ir - Wilkinson's catalyst. Pt complexes in the treatment of cancer. Preparation and properties of $PtCl_4$, H_2PtCl_6 and Cis-$PtCl_2(NH_3)_2$.	
II	Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions and reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.	**12**
III	Electronic Spectra and Magnetic properties of transition metal Complexes:	**12**

	Spectroscopic ground states, Selection rules, mechanism for breakdown of the selection rules, intensity of absorption, band width correlation, Orgel and Tanabe- Sugano diagram for transition metal complexes(d^1-d^9states), spectra of d-d metal complexes of the type $[M(H_2O)_6]n+$, spin free and spin paired ML_6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelauxetic series. Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equillibria in octahedral stereochemistry.	
IV	Transition Metal Complexes: Transition metal complexes with unsaturated organic molecules- alkanes, ally!, diene dienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features. Important reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis. Transition Metal Complexes with Bond to hydrogen.	**12**
V	Alkyls And Aryls Of Transition Metals: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis. Compounds Of Transition Metal-Carbon Multiple Bonds: Alkylidenes, low valent carbenes, nature of bond and Structural characteristics. Fluxional Organometallic Compounds: Fluxionality and dynamic equilibria in compounds such as olefin, allyl and dienyl complexes.	**12**

Self study	Energy profile of a reaction, reactivity of metal complexes	

Text Books

1. Malik, W.U., Tuli, G.D. &Madan, R.D, 2012. Selected topics Inorganic Chemistry. (5thed.). New Delhi: S. Chand Company Ltd.
2. Puri B.R., Sharma, L.R. &Kalia, K.C, 2012. Principles of Inorganic Chemistry. (4th ed.). India: Milestone publishers.
3. Lee, J.D, 2008. Concise Inorganic Chemistry. (5th ed.). India: Wiley India.

Reference Books

1. Cotton, F.A. & Wilkinson. G, 1970. Advance Inorganic Chemistry. (2nd ed.). India: Wiley Eastern Private Ltd.
2. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K, 2011. Inorganic Chemistry: Principles of Structure and Reactivity. (4thed.). India: Pearson Education.
3. Mehrotra, R. C. & Singh. A, 2014. Organometallic Chemistry. (2nded.) New Delhi: New Age International Ltd.
4. Parkins, A. W. &Poller, R. C, 1987. An Introduction to Organometallic Chemistry. Chennai: Oxford University Press.
5. Dougles, B.E., McDaniel, D.H.& Alexander, J.J, 1983. Concepts and Models of Inorganic Chemistry. (2nd ed.). New York: John Wiley and Sons Ltd.
6. Miessler, G.L, 2004. Inorganic Chemistry. (3rd ed.).India: Pearson Education.

Web Resources

1. https://kolhanuniversity.ac.in/index.php/students/downloads/send/24-chemistry/3003-1st-lecture-on-chemistry-of-elements-of-2nd-and-3rd-transition-series-docx.html
2. https://www.dalalinstitute.com/wp-content/uploads/Books/A-Textbook-of-Inorganic-Chemistry-Volume-1/ATOICV1-3-0-Reaction-Mechanism-of-Transition-Metal-Complexes-I.pdf
3. https://www.dalalinstitute.com/wp-content/uploads/Books/A-Textbook-of-Inorganic-

Chemistry-Volume-1/ATOICV1-8-0-Electronic-Spectra-of-Transition-Metal-Complexes.pdf

4. https://employees.csbsju.edu/cschaller/Principles%20Chem/New_Folder/TMligands.htm
5. https://www.magadhuniversity.ac.in/download/econtent/pdf/E-Content_Transition%20metal-alkyl%20and%20metal-aryl%20complexes.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	3	3	3	3	3
CO2	2	3	3	2	3	2	2	3	3	2	3	2
CO3	3	2	2	2	3	3	3	2	3	3	2	2
CO4	2	3	3	3	2	2	2	3	2	3	3	3
CO5	3	3	3	3	3	3	3	2	3	3	2	3
TOTAL	13	14	14	13	13	13	13	13	14	14	13	13
AVERAGE	2.6	2.8	2.8	2.6	2.6	2.6	2.6	2.6	2.8	2.8	2.6	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER II
ELECTIVE COURSE IV: a) BIO-INORGANIC CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC4	3	1	-	-	3	4	60	25	75	100

Pre-requisites:

The student should know the biological importance of Chemistry

Learning Objectives:

1. To understand the role of trace elements.
2. To study the toxicity of metals in medicines.
3. To have knowledge on diagnostic agents.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1.	understand the importance trace elements in biological processes.	**K1& K2**
2.	analyze the mechanism of biological redox systems.	**K2& K4**
3.	interpret the role of nitrogen in biological systems.	**K2& K3**
4.	identify the toxicity of metals and suggest suitable diagnostic agents for cancer treatment.	**K4& K5**
5.	evaluate the kinetics and effect of pH, temperature on enzyme reactions	**K3 & K5**

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

Units	Contents	No. of Hours
I	Essential trace elements: Selective transport and storage of metal ions: Ferritin, Transferrin and siderophores- Sodium and potassium transport, Calcium signaling proteins. Metallo enzymes: Zinc enzymes– carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.	**12**
II	Transport Proteins: Oxygen carriers-Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN– to Myoglobin and Hemoglobin .Biological redox system: Cytochromes-Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers-Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.	**12**
III	Nitrogen fixation-Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis:photosystem-I and photosystem-II-chlorophylls structure and function.	**12**
IV	Metals in medicine: Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb.Therapeutic Compounds:Vanadium-Based Diabetes Drugs; Platinum-Containing	**12**

	Anticancer Agents.Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. Temperature and critical magnetic Field.	
V	Enzymes -Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.	**12**

Self study	Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme

Text books

1. Williams,D.R, 2001. –Introdution to Bioinorganic chemistry.
2. K.F. Purcell and Kotz, 2010.Inorganic chemistry, WB Saunders Co., USA.
3. G.N. Mugherjea and Arabinda Das, 1993. Elements of Bioinorganic Chemistry. T. M. Loehr 1989. Iron carriers and Iron proteins, VCH

Reference books

1. R. Gopalan, V. Ramalingam, 2001. Concise Coordination Chemistry, S. Chand.
2. M.Satake and Y.Mido, 1996. Bioinorganic Chemistry- Discovery Publishing House, New Delhi
3. M.N. Hughes, 1982. The Inorganic Chemistry of Biological processes, II Edition, Wiley London.
4. R. W. Hay, 1987. Bio Inorganic Chemistry, Ellis Horwood.
5. R. M. Roat-Malone, 2002. Bio Inorganic Chemistry, John Wiley.

Web Resources

1. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry-the-instant-notes-chemistry-series-d162097454.html
2. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry-5th-edition-d161563417.html
3. https://crk-umn.libguides.com/chemistry/web
4. https://onlinelibrary.wiley.com/doi/book/10.1002/9781119951438
5. https://www.sciencedirect.com/journal/bioorganic-chemistry

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	3	3	3	3	2	2	3	3	3	2	3	3
CO 2	3	3	2	3	3	3	3	3	2	3	3	3
CO 3	3	3	3	2	3	3	2	2	3	2	3	3
CO 4	3	2	3	2	3	2	3	2	3	3	3	2
CO 5	3	3	2	2	3	2	3	3	3	3	3	3
Total	15	14	13	12	14	12	14	13	14	13	15	14
Average	3	2.8	2.6	2.4	2.8	2.4	2.8	2.6	2.8	2.6	3	2.8

3 – Strong, 2- Medium, 1- Low

SEMESTER II
ELECTIVE COURSE IV: b) MATERIAL SCIENCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC5	3	1	-	-	3	4	60	25	75	100

Pre-requisites:

The student should know the basic knowledge of properties of crystals and crystal growth.

Learning Objectives:

1. To understand the crystal structure, growth methods and X-ray scattering.
2. To explain the optical, dielectric and diffusion properties of crystals.

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Course Outcomes

On the successful completion of the course, student will be able to**:**		
1.	understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	**K1 & K2**
2.	apply and assess the structure of different materials and their properties.	**K3**
3.	analyse and identify new materials for energy applications.	**K4**
4.	validate the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.	**K5**
5.	design and develop new materials with improved property for energy applications.	**K6**

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

Units	Contents	No. of Hours
I	Crystallography Symmetry - unit cell and Miller indices -crystal systems - Bravais lattices - point groups and space groups - X-ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method and applications.	**12**
II	Crystal growth methods Nucleation–equilibrium stability and meta stable state. Single crystal – Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods-nucleation–equilibrium stability and meta stable state. Single crystal–Low and high temperature, solution growth– Gel and sol-gel. Melt growth - Bridgeman-Stock barger, Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.	**12**

III	**Properties of crystals** Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarization - electronic, ionic, orientation, and space charge polarization. Effect of temperature. dielectric constant, dielectric loss. Types of dielectric breakdown–intrinsic, thermal, discharge, electrochemical and defect breakdown.	**12**
IV	**Special Materials** Superconductivity: Meissner effect, Critical temperature and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and giant magneto resistance. Ferro, ferri and anti-ferromagnetic materials-applications, magnetic parameters for recording applications. Ferro-, Piezo-, and pyro electric materials – properties and applications. Shape memory alloys-characteristics and applications, Non-linear optics-Second Harmonic Generators, mixing of Laser wavelengths by quartz, ruby and $LiNbO_3$.	**12**
V	**Materials for Renewable Energy Conversion** Solar Cells: Organic, bilayer, bulk hetero junction, polymer, perovskite based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO2 and N2. Manganese based photo systems for water-splitting. Complexes of Rh, Ru, Pd and Pt - photochemical generation of hydrogen from alcohol.	**12**

Self study	Crystal systems and X-ray diffraction.	

Text books

1. S. Mohan and V. Arjunan, 2016. Principles of Materials Science, MJP Publishers.
2. Arumugam, 2007. Materials Science, Anuradha Publications.
3. Giacavazzo et. al., 2010. Fundamentals of Crystallography, International Union of Crystallography. Oxford Science Publications.
4. Woolfson, 2012. An Introduction to Crystallography, Cambridge University Press.
5. James F. Shackelford and Madanapalli K. Muralidhara, 2007. Introduction to Materials Science for Engineers. 6th ed., PEARSON Press.

Reference Books

1. M.G. Arora, 2001. Solid State Chemistry, Anmol Publications, New Delhi.
2. R.K. Puri and V.K. Babbar, 2001. Solid State Physics, S Chand and Company Ltd.
3. C. Kittel,1966. Solid State Physics, John-Wiley and sons, NY.
4. H.P. Meyers, 1998. Introductory Solid State Physics, Viva Books Private Limited.
5. A.R. West, 1987. Solid State Chemistry and Applications, John-Wiley and sons.

Web Resources

1. http://xrayweb.chem.ou.edu/notes/symmetry.html.
2. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.
3. https://bit.ly/3QyVg2R
4. https://www.library.qmul.ac.uk/subject-guides/engineering-and-materials-science/useful-websites/
5. https://libguides.northwestern.edu/mse

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	2	2	3	3	3	2	3	3
CO 2	2	3	2	3	3	3	3	3	2	3	3	3
CO 3	3	2	3	2	3	3	3	2	3	2	3	3
CO 4	3	2	3	2	3	2	3	3	3	3	3	2
CO 5	3	3	2	2	3	2	3	3	2	3	3	3
Total	14	13	13	12	14	12	15	14	13	13	15	14
Average	2.8	2.6	2.6	2.4	2.8	2.4	3	2.8	2.6	2.6	3	2.8

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE IV: c) ORGANOMETALLIC CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232EC6	**3**	**1**	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisites:

The student should know the basic knowledge of coordination chemistry.

Learning Objectives:

1. To recall the basic concepts of organometallic, supramolecular and bio-organometallic chemistry.
2. To predict the properties and applications of various organometallic compounds.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1.	understand the basic concepts of organometallic, supramolecular and bio-organometallic chemistry.	**K1 & K2**
2.	apply the basic concepts to understand the reactive mechanism of organometallic compounds as catalysts.	**K3**
3.	analyse the nature of bonds, types and various theories of organometallic compounds.	**K4**
4.	evaluate the different types of reactions in metal carbonyls, cluster and polymers .	**K5**
5.		
6.	synthesize cancer drugs from organometallic compounds and supramolecules in the biosystems.	**K6**

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

Units	Contents	No. of Hours
I	**Organometallic compounds** Introduction: Classification, hapticity. Nomenclature, 14-, 16- and 18-electron rule-counting electrons in ligands. Preparation, structure and properties of organometallics of alkali (Li) and alkaline earth metals (Grignard reagents), group 13-15 elements and comparison with Group-12 elements. σ- bonded organometallics of transition elements: Synthesis, carbanion exchange, transmetalation, elimination, cyclo-metalation and metal atom reactions. M-C bond cleavage (Ti and Zr complexes), alkene elimination and proton abstraction, adduct formation and insertion reactions. π- bonded organometallics of transition elements: Classification of ligands, synthesis, reactions, structure and bonding-metal carbene, carbyne complexes, Fischer and Schrock carbine complexes and Zeise's salt. Enyl complexes: Classification, Allyl(η^3) complexes–synthesis, reactions, structure and bonding-stereoisomerism, fluxional behaviour. Cyclopentadienyl (η^5) complexes: Metallocene-synthesis, properties, structure, bonding (MOT) in ferrocene, nickelocene,	**12**

	cobaltocene, uranocene and vanadocene. Reactions of ferrocene.	
II	**Reactions and Catalysis** Reactions: Nucleophilic substitution– dissociative and associative mechanisms, photochemical reactions of metal carbonyls, insertion and deinsertion, carbonylation and decarbonylation reactions. Mechanism and stereochemistry of oxidative addition, reductive elimination, transmetalation, carbometalation, migratory insertion, β–hydride elimination. Organometallics as catalyst: Hydrogenation of alkene-Wilkinson's catalyst, oxo process, Wacker process, monsanto acetic acid synthesis, ZieglerNatta catalyst-polymerization of olefin. Preparation of synthesis and water gas shift reactions, synthetic gasoline-ZSM-5 catalyst and Fischer–Tropsch process. Palladium metal-based coupling reactions: Heck reaction, Suzuki coupling, Sonogashira coupling, Stille coupling, Negishi coupling reactions.	**12**
III	**Metal Carbonyls, Clusters and Polymers** Metal carbonyls: Introduction, metal–metal bonding, preparation, structure and bonding (MOT) of CO, evidence of π–back bonding, spectral distinction of bridging and terminal. Nucleophilic and electrophilic additions, Collman's reagent and migratory insertion. Transition metal clusters: Introduction, classification, structural characteristics, cluster geometries, tri-, tetra-, penta-, hexanuclear. Bonding: polyhedral skeletal electron pair theory, isolobal relationships, reactivity and catalysis. Mixed clusters: Structure and bonding in hydride and carbide clusters. Wade's rule, halide cluster, Chevrel phases, zintel ions, capping and Mingo's rule. Organometallic polymers: Introduction, ferrocene-based condensation polymers.	**12**
IV	**Supramolecular chemistry** Host-guest chemistry: Classifications, thermodynamics and kinetic stability, lock and key model, macrocyclic systems-crown ethers. Molecular recognition: Role of crown ether, rodents, cryptands, spherands, calixarenes and siderophores. Dendrimers: Synthesis–divergent and convergent, dendrimeric photochemical device. Molecular wires, switches and rectifiers-Applications.	
	Supramolecular chemistry Host-guest chemistry: Classifications, thermodynamics and kinetic stability, lock and key model, macrocyclic systems-crown ethers. Molecular recognition: Role of crown ether, rodents, cryptands, spherands, calixarenes and siderophores. Dendrimers: Synthesis–divergent and convergent, dendrimeric photochemical device. Molecular wires, switches and rectifiers-Applications.	**12**
V	**Bio-organometallic Chemistry** Organometallic enzymes: coenzymes, vitamin B_{12}.correnoid-reactions, mimic compounds of vitamin B_{12}. Heavy metal poisoning–mercury and arsenic.	

	Organometallic drugs: anticancer (Ru) and ferrocifen-mechanism, antimalarial drug ferroquine, radiopharmaceuticals, tracers, ionophores and sensors	**12**

Self study	18e- rule, vitamins

Text Books

1. R. Gopalan, V. Ramalingam, 2001. Concise Coordination Chemistry, S. Chand,
2. F. A. Cotton and G. W. Wilkinson,1988. Advanced Inorganic Chemistry, 5th edn, John Wiley & Sons,.
3. K. F. Purcell and J. C. Kotz, 1976. Inorganic Chemistry; Saunders: Philadelphia.
4. Ajai Kumar, 2020.Coordination Chemistry, 6th edn., Aaryush Education.
5. B. D Gupta and A.J Elias, 2013.Basic Organometallic Chemistry, 2nd edn., Universities Press.

Reference books

1. J. E. Huheey, E. A. Keiter and R. L. Keiter,1993. Inorganic Chemistry, Principle, structure and reactivity, 4 th edn., Harper Collins.
2. D. F. Shriver and P. W. Atkins, 2008.Inorganic Chemistry, 3rd edn., Oxford,
3. B. E. Douglas, D. H. McDaniel and J. J. Alexander, 1993.Concepts and Models of Inorganic Chemistry, 3 rdedn., John Wiley,.
4. A. Yamamoto, 1986.Organotransition Metal Chemistry: Fundamental Concepts and Applications, John Wiley.
5. T.P. Fehlner, J. Halet, J. Saillard, 2007. Molecular clusters: a bridge to solid-state chemistry Cambridge University Press,.

Web Resources

1. https://bit.ly/3OxwNt5
2. https://bit.ly/3n7weum
3. https://bit.ly/3bhcJw

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	3	2	2	3	3	3	2	3	3
CO 2	3	3	2	3	3	3	3	3	2	3	3	3
CO 3	3	2	3	2	3	3	3	2	3	2	3	3
CO 4	3	2	3	3	3	2	3	2	3	3	2	2
CO 5	3	2	2	2	3	2	3	3	2	3	3	2
Total	15	12	13	13	14	12	15	13	13	13	14	13
Average	3	2.4	2.6	2.6	2.8	2.4	3	2.6	2.6	2.6	2.8	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER II
SKILL ENHANCEMENT COURSE I: HEALTH SCIENCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP232SE1	3	1	-	-	2	4	60	25	75	100

Pre-requisites:

Students should know the role of drugs and vitamins in health.

Learning Objectives:

1. To respond to critical needs in various healthcare settings
2. To develop and use the skills necessary to positively impact health care.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	recall and understand the importance of health, drugs, body fluids and vitamins	**K1&K2**
2	apply the function of drugs, nutrients, vitamins and their mode of action	**K3**
3	analyze and identify blood group and matching.	**K4**
4	evaluate the functions of drugs and vitamins	**K5**
5	develop skills to identify blood group and assist in first aid to provide health care to the community.	**K6**

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

Units	Contents	No. of Hours
I	Health - mental health and physical health - food pyramid - types of malnutrition - causes and remedies - macro and micronutrients - carbohydrates - classification and their biological functions, proteins-classification and their biological functions, vitamins - classification and their biological functions - dietary elements (Na, K, Ca, P, Mg, S, Fe, Zn, Se, Mo)	**12**
II	Drugs - classification of drugs - drugs acting on CNS - general anaesthetics, hypnotics & sedatives, narcotics, antipyretics, antirheumatics, analgesics, anticonvulsants and antitussives - chemotherapeutic drugs - antibiotics, antiseptics and disinfectants - cardiovascular agents - anti cancer drugs - adverse effects of drugs.	**12**
III	Body Fluids-composition of blood- blood volume, blood grouping - identification of blood groups and matching. Determination of glucose in serum, Tests for salts in serum and urine-functions of blood, blood pressure, anaemia, blood sugar - respiration - oxygen and carbon dioxide transport in blood - haemoglobin -myoglobin - composition of urine - electrolyte balance - Na/K pump.	**12**
IV	Health and Safety- Safety in laboratory – importance, personal protection – dangers to avoid – chemical hazards – acid burns – acid and alkali on eye,	**12**

	poisoning by strong acids, caustic alkali. Hazards of carbon monoxide. First-aid box- Rules of first aid, first aid for accidents, cuts, bruises. bleeding, fracture, burns, fainting and poisonous bites.	
V	Common and Vitamin Deficiency Diseases-Jaundice, cancer, kidney stone - typhoid, dengue, ulcer, goiter, diabetes, rickets, scurvy, beriberi, pellagra, night blindness, Covid-19 - causes - symptoms - diagnosis - vaccines/treatment.	**12**

Self study	Vitamins and their importance	

Text Books

1. Ramani A V, 2009. *Food Chemistry*, MJP Publishers, Chennai.
2. Ghosh, J A, 1999. *Text book of Pharmaceutical Chemistry*, S. Chand and Co. Ltd,

Reference Books

1. Ashutosh Kar, 1993. *Medicinal Chemistry*, Wiley Easterns Limited, New Delhi,.
2. Deb A C, 1994. *Fundamentals of Biochemistry*, New Central Book Agency, Calcutta,
3. Parul R. Sheth, 2000. *Chemicals of Life*, National Institute of Science Communication (CSIR),.
4. Ashutoshkar, 1996. Medicinal Chemistry -, New age International (p) Ltd, publishers.
5. Weil, J. H. &Wilfy. 1987. General Bio Chemistry, (6th ed.). Eastern publishers.

Web Resources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4940574/
2. https://accessmedicine.mhmedical.com/content.aspx?bookid=2249&sectionid=175218675
3. https://egyankosh.ac.in/bitstream/123456789/38330/1/Unit%209.pdf
4. https://conursing.uobaghdad.edu.iq/wp-content/uploads/sites/20/2019/10/Physiology-of-Body-Fluids.pdf
5. https://ucblueash.edu/content/dam/refresh/blueash-62/documents/academics/academic-departments/chemistry/LabSafetyRules.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2	3	3	3	3	3	3	3
CO2	2	3	3	2	3	2	2	3	3	2	3	2
CO3	3	2	2	2	3	3	3	2	3	3	2	2
CO4	2	3	3	3	2	2	2	3	2	3	3	3
CO5	3	3	3	3	3	3	3	2	3	3	2	3
TOTAL	13	14	14	13	13	13	13	13	14	14	13	13
AVERAGE	2.6	2.8	2.8	2.6	2.6	2.6	2.6	2.6	2.8	2.8	2.6	2.6

3 – Strong, 2- Medium, 1- Low

SEMESTER – I & II
LIFE SKILL TRAINING – I ETHICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST1	1				1	1	15	-	50	100

Prerequisites: Value education-its purpose and significance in the present world

Learning Objectives

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

Course Outcomes	On completion of this course the student will be able to	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	K3

Unit	Contents	No. of Hours
I	**Goal Setting:** Definition - Brainstorming Session – Setting Goals – Few components of setting goals.	3
II	**Group Dynamics:** Definition - Nature of Groups – Types of Groups – Determinants of group behavior	3
III	**Conflict Resolution:** Definition – What is a conflict resolution - Why should conflicts be resolved? - Lessons for life	3
IV	**Decision Making:** Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making	3
V	**Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
TOTAL		15

Self-Study Portion: Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.

Textbooks

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. Irai Anbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Private Limited, 2019.
5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

Web Resources

1. https://positivepsychology.com/goal-setting-exercises/
2. https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf
3. https://en.wikipedia.org/wiki/Conflict_resolution
4. https://asana.com/resources/decision-making-process
5. https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434