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 - IV

Guidelines & Syllabus

DEPARTMENT OF CHEMISTRY

2023-2026

(With effect from the academic year 2024-2025)

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

Graduate Attributes

Graduates of our College develop the following attributes during the course of their studies.

- **Creative thinking:**

  Equipping students with hands-on-training through skill based courses and promote startup.
- **Personality development:**

  Coping with increasing pace and change of modern life through value education, awareness on human rights, gender issues and giving counselling for the needful.
- **Environmental consciousness and social understanding:**

  Reflecting upon green initiatives and understanding the responsibility to contribute to the society; promoting social and cultural diversity through student training and service learning programmes.
- **Communicative competence:**

  Offering effective communication skills in both professional and social contexts through bridge courses and activities of clubs and committees.
- **Aesthetic skills:**

  Engaging mind, body and emotions for transformation through fine arts, meditation and exercise; enriching skills through certificate courses offered by Holy Cross Academy.
- **Research and knowledge enrichment:**

  Getting in-depth knowledge in the specific area of study through relevant core papers; ability to create new understanding through the process of critical analysis and problem solving.
- **Professional ethics:**

  Valuing honesty, fairness, respect, compassion and professional ethics among students. The students of social work adhere to the *National Association of Social Workers Code of Ethics*
- **Student engagement in the learning process:**

  Obtaining extensive and varied opportunities to utilize and build upon the theoretical and empirical knowledge gained through workshops, seminars, conferences, industrial visits and summer internship programmes.
- **Employability:**

  Enhancing students in their professional life through Entrepreneur development, Placement & Career guidance Cell.
- **Women empowerment and leadership:**

  Developing the capacity of self-management, team work, leadership and decision making through gender sensitization programmes.

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)

PSOs	Upon completion of M.Sc Chemistry programme, the graduates will be able to:	Mapping with POs
PSO1	impart in-depth knowledge about various aspects of chemistry within an environment committed to excellence	**PO1**
PSO2	develop critical thinking, technical skills and innovative ideas in analysing and solving problems in the field of chemistry	**PO2, PO3**
PSO3	explore and expedite the recent avenues in chemistry research across the globe with professional competency	**PO4**
PSO4	inculcate positive approach towards environment and ecology from the chemistry perspective	**PO4, PO7**
PSO5	promote entrepreneurial skills and become self-reliant	**PO5, PO6**

Mapping of POs and PSOs

POs	PSO1	PSO 2	PSO3	PSO4	PSO5
PO1	3	3	2	3	2
PO2	3	2	3	3	3
PO3	3	3	3	2	2
PO4	3	3	2	3	3
PO5	3	3	3	2	3
PO6	2	3	3	3	2
PO7	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 Lab Course	4x100	400
Core Research Project	1x100	100
Elective courses	7x100	700
Total marks	**20x100**	**2000**

Course Structure

Distribution of Hours and Credits

Course	SEMESTER				Total	
	I	**II**	**III**	**IV**	**Hours**	**Credits**
Core– Theory	7(5) + 7(5)	6(5)+ 6 (5)	6 (5) + 6 (5) + 6 (5)	6 (5) + 6 (5) 6 (5)	74	58
Core Lab Course	6 (4)	6 (4)				
Elective Course	5 (3) + 5 (3)	4 (3) + 4 (3)	4 (3) -	4(3) 4(3)	30	21
Core Research Project	-	-	5(4)		5	4
Skill Enhancement Course	-	4 (2)	3 (2)	4 (2)	11	6
Internship	-	-	(2)		-	2
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		(1)			1

Activity (UBA)					

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	4
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**

SEMESTER III

Course Code	Title of the Course	Credits	Hours / Week
CP233CC1	Core Course V: Organic Synthesis and Photochemistry	5	6
CP233CC2	Core Course VI: Coordination Chemistry I	5	6
CP233CP1	Core Lab Course III: Physical Chemistry Practical	5	6
CP233RP1	Core Research Project	4	5
CP233EC1	Elective Course V: a) Research Tools and Techniques	3	4
CP233EC2	Elective Course V: b) Pharmacognosy and Phytochemistry		
CP233EC3	Elective Course V: c) Surface Chemistry and Catalysis		

CP233SE1	Skill Enhancement Course II: Chemical Analysis - Tools and Techniques	2	3
CP233IS1	Internship	2	-
	Total	**26**	**30**

SEMESTER IV

Course Code	Title of the Course	Credits	Hours/ Week
CP234CC1	Core Course VII: Coordination Chemistry II	5	6
CP234CC2	Core Course VIII: Physical Chemistry II	5	6
CP234CP1	Core Lab Course IV: Analytical Instrumentation Techniques Practical	5	6
CP234EC1	Elective Course VI: a) Polymer Chemistry	3	4
CP234EC2	Elective Course VI: b) Biomolecules and Heterocyclic Compounds		
CP234EC3	Elective Course VI: c) Chemistry of Natural Products		
CP234EC4	Elective Course VII: a) Renewable Energy Sources	3	4
CP234EC5	Elective Course VII: b) Supramolecular Chemistry		
CP234EC6	Elective Course VII: c) Environmental Science		
CP234SE1	Skill Enhancement Course III: Business skills for Chemists	2	4
	Total	23	30

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 Activity (UBA)	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	GVAC2401 -	Generic Value-added Course	1+1
		Total	**10**

Specific Value-added Course

Semester	Title of the Course	Course Code
I	Herbal Product Development and Formulation	CP231V01
I	Ecology and Waste Management	CP231V02
III	Food Preservation and Technology	CP233V01
III	Paints and Coatings	CP233V02

Self-Learning Course:

Semester	Title of the Course	Course Code
III	Petrochemicals and Cosmetics	CP233SL1
IV	Chemistry for Competitive Examinations	CP234SL1

Examination Pattern

Curricular Courses:

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 2 x 6 (Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 2 x 12 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	**100**

ii) Core 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) Core Research 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**

iv) Skill Enhancement Course

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

Internal Components and Distribution of Marks

Components	Marks
Internal test (2) – (40 marks)	10
Quiz (2) – (20 marks)	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 4 (Open choice any **Five** out **of Eight**)	20
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 9 (Open choice any **Five** out **of Eight**)	45
Total	**25**	**Total**	**75**

v) Internship

Components	Marks
Industry Contribution	50
Report & Viva-voce	50
Total	**100**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		Marks
Life Skill Training -I	Album (20 pages)	30
	Group Activity (Group of 5 students)	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
Field Project Report & Viva-voce	50
Total	**100**

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

Components	Marks
Internal	25
External	75
Total	**100**

(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**

(v)Self Learning Course

Internal	**Marks**	**External**	**Marks**
Part A 10x1	10	Part A 25 x 1	25
Part B 3 x 5 (Three out of five)	15	Part B 10x5 (Ten out of twelve)	50
Total	**25**	**Total**	**75**

Outcome Based Education (OBE)

(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	2	1	1	8
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

The levels of assessment are flexible and it should assess the cognitive levels and outcome attainment.

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.
v. 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 5.0	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** 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	**21**

	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**
	Total	**105**
Self study	Reaction mechanisms and Conformations of simple organic compounds.	

Textbooks

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** X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle	**21**

	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**
	Total	**105**
Self-study	Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice	

Textbooks

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	
	Total	**90**
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 I: 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**
	Total	**75**
Self-study	Introduction of nanomaterials and nanotechnologies, Introduction-role of size, classification-0D, 1D, 2D, 3D. Synthesis-Bottom –Up, Top–Down.	

Textbooks

1.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 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	15

	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**
	Total	**75**
Self-study	**Physical properties in Pharmaceuticals:** Physical properties of drug molecule: physical properties. Refractive index- Definition, explanation, formula, importance, determination, specific & molar refraction.	

Textbooks

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 pentahydrate by DTA. Differential scanning calorimetry (DSC) - principle -	**15**

	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**
	Total	**75**
Self-study	Significant figures - rounding off the values - accuracy and precision. Errors - classification of errors. Expression and calculation of errors in different forms.	

Textbooks

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**
	Total	**75**
Self study	Arrhenius theory -limitations, van't Hoff factor Behaviour of electrodes: Standard electrodes	

Textbooks

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 of isotopic substitution. Diatomic vibrating rotor, vibrational-rotational spectra of diatomic molecules, P, R branches, breakdown of the Born-	**15**

	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**
	Total	**75**
Self study	Electronic transitions, NMR introduction	

Textbooks

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**
	Total	**75**
Self-study	Pigments - Classification, Manufacture and uses. Dyes - Classification, preparation, dyeing processes.	

Textbook

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	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231V01	2	-	-	-	1	2	30	25	75	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**

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

Units	Contents	No. of Hours
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.	**6**
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.	**6**
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	**6**

	bioactivity.	
IV	**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.	**6**
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	**6**
	Total	**30**
Self-study	Chromatographic techniques, Phyto constituents	

Textbooks

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,.

Reference Books

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.

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 I

SPECIFIC VALUE-ADDED COURSE: ECOLOGY AND WASTE MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP231V02	2	-	-	-	1	2	30	25	75	100

Pre-requisite: Knowledge on environment and types of wastes

Learning Objectives:

1. To highlight the need for waste management practices to mitigate environmental degradation and promote sustainability.
2. To encourage the adoption of the 3R principles at home, in the city, and at the national level to minimize waste generation

Course Outcomes

On the successful completion of the course. students will be able to:		
1	recognize the importance of biodiversity in maintaining balanced ecosystem	**K1**
2	know the principle of waste management and disposal of waste	**K2**
3	apply 3R principle to minimize the waste	**K3**
4	analyze the environmental issues associated with pollution and identify the strategies for proper disposal of waste	**K4**
5	evaluate the consequences of environmental degradation	**K5**

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

Units	Contents	No. of Hours
I	**Ecosystem** Introduction to environment-Eco system-balanced eco system-human activities-effects of human activities on environment-Need for public awareness-Health Risk & Vulnerability of humans due to environmental Degradation	**6**
II	**Ecology** Ecology- biodiversity-impact of economy on ecology-restoration-biodiversity threats and conservation	**6**
III	**Waste management** Introduction to waste management-Environmental issues –ways of environmental pollution-need of waste management- State of municipal waste generation in the world-ways of dealing with municipal solid waste-sanitary land fill- recycling of plastic	**6**
IV	**Liquid waste management** Liquid waste management-hazardous and toxic waste-Municipal waste handling in Indian cities and towns- Bio medical and chemical waste- Nuclear and E waste-environmental consequences of ship breaking- polluting industries of India-hazardous waste from other countries to India	**6**
V	**Disposal of solid waste** Disposal of solid waste and management -3R system –new technologies in 3R -3R in home-3R in our country- ways of minimizing wastages- home-city-country-organic waste management - waste prevention-Climate change and adaptation	**6**
	Total	**30**
Self-study	Introduction – Environmental science – Environmental chemistry – Ecology – Definition – Ecosystem	

Textbooks:

1. Diganta Bhusan Das and Ramesha Chandrappa, 2012. *Solid Waste Management: Principles and Practice*, Springer.

2. Daniel B. Botkin, Edward A. Keller, 2014. *Environmental Science: Earth as a Living Planet*, 9th Edition, Wiley.
3. George Tchobanoglous, Frank Kreith, 2002. *Handbook of Solid Waste Management*, 2nd Edition, McGraw-Hill Education.
4. Eugene P. Odum, Gary W. Barrett, 2004. *Fundamentals of Ecology*, 5th Edition, Brooks Cole.
5. Sharma B.K. and Kaur. H., 1997. *Environmental Chemistry*. McGraw-Hill Publishers.

Reference Books:

1. A.K. Mukherjee, 1986. *Environmental Pollution and Health Hazards, Causes and Control*, Galgotia Press, New Delhi.
2. N. Manivasakam, 1985. *Physicochemical Examination of Water. Sewage and Industrial Effluents*., Pragati Prakashan Publication, Meerut.
3. Manuel C. Molles, 2019. *Ecology: Concepts and Applications*, 8th Edition, McGraw-Hill Education.
4. George Tchobanoglous, Hilary Theisen and Samuel Vigil, 1993. *Integrated Solid Waste Management: Engineering Principles and Management Issues*, 2nd Edition, McGraw-Hill Education.
5. John Pichtel, 2014, *Waste Management Practices: Municipal, Hazardous, and Industrial*, 2nd Edition, CRC Press.

Web Resources:

1. https://libraryguides.uwsp.edu/c.php?g=525918&p=3595625
2. http://www.wrfound.org.uk/
3. https://moef.gov.in/moef/environment/waste-management/index.html
4. https://www.inderscience.com/jhome.php?jcode=ijewm
5. https://solarimpulse.com/waste-management-solutions

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	2	2
CO2	2	2	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	2	2
CO4	3	3	3	3	2	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	3	3	2
TOTAL	**14**	**14**	**15**	**14**	**13**	**15**	**13**	**13**	**14**	**15**	**13**	**12**
AVERAGE	**2.8**	**2.8**	**3**	**2.8**	**2.6**	**3**	**2.6**	**2.6**	**2.8**	**3**	**2.6**	**2.4**

3 – Strong- 2- Medium- 1- Low

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**
	Total	**90**

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**
	Total	**90**

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

Textbooks

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.Benjamin Publishers, 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., 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
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. 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.	**30**

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, magnesium trisilicate, aluminium hydroxide gel, $HgCl_2$, HgI_2 and $Hg(CN)_2$ as disinfectants.	**12**
	Total	**60**

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**
	Total	**60**

Self study	Principles of green chemistry

Textbooks

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

Course Code	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-$PtCl_2(NH_3)_2$.	**12**
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: 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.	**12**
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	**12**

	nucleophilic and electrophilic attack on ligands and organic synthesis. Transition Metal Complexes with Bond to hydrogen.	
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**
	Total	**60**

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

Textbooks

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 Anticancer Agents.Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents. Temperature and critical magnetic Field.	**12**
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**
	Total	**60**

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

Textbooks

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. .

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.

Textbooks

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

	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	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.	synthesize cancer drugs from organometallic compounds and supramolecules in the biosystems.	**K6**

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, cobaltocene, uranocene and vanadocene. Reactions of ferrocene.	**12**

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

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.	**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**
	Total	**60**

Self study	18e- rule, vitamins

Textbooks

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, 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.	**12**
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**
	Total	**60**

Self study	Vitamins and their importance	

Textbooks

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	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		
1	understand deeper insight of the meaning of their existence.	**K1**
2	recognize the philosophy of life and individual qualities	**K2**
3	acquire the skills required for a successful personal and professional life.	**K3**
4	develop as socially responsible citizens.	**K4**
5	create a peaceful, communal community and embrace unity.	**K3**

K1-Remember;K2-Understand;K3-Apply;K4-Analyze

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:	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 hallenges. 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

SEMESTER III

CORE COURSE V: ORGANIC SYNTHESIS AND PHOTOCHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CC1	5	1	-	-	5	6	90	25	75	100

Pre-requisites:

Basic knowledge of organic chemistry

Learning Objectives:

1. To understand the molecular complexity of carbon skeletons and the presence of functional groups and their relative positions.
2. To study various synthetically important reagents for any successful organic synthesis.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall the basic principles of organic chemistry and understand the various reactions of organic compounds with reaction mechanisms.	**K1 & K2**
2.	apply the versatility of various special reagents and to correlate their reactivity with various reaction conditions.	**K3**
3.	analyze the synthetic strategies in the preparation of various organic compounds.	**K4**
4.	evaluate the suitability of reaction conditions in the preparation of tailor-made organic compounds.	**K5**
5.	design and synthesize novel organic compounds with the methodologies learnt during the course.	**K6**

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

Units	Contents	No. of Hours
I	**Planning an Organic Synthesis:** Preliminary Planning- steps in planning the synthesis- Retrosynthetic Analysis and its terminologies- linear and convergent approach-advantages of convergent synthesis - Target molecule- synthons and synthetic equivalents- types of synthons: donor and acceptor synthons. Transformations in Retrosynthesis- Functional group addition and interconversions. Monofunctional disconnection: alcohol disconnection - ketone disconnection - acid and their derivatives disconnection - amide disconnection - Bifunctional 1-2, 1-3, 1-4 and 1-5 disconnections.	**18**
II	**Organic Synthetic Methodology:** Control elements-Regiospecific control elements. Use of protective groups - protection of hydroxyl- carboxyl- carbonyl and amino groups- activating groups. Latent polarity. Synthesis based on umpolung concepts of Seebach - typical examples. Designing synthesis: Disconnection approach in Cis-jasmone- Epothilone- Juvabione- bisabolene and longifolene. Synthetic uses of nitrocompounds and alkenes	**18**
III	**Pericyclic Reactions:** Characteristics and classifications of pericyclic reactions - Cycloaddition - Electrocyclic - Chelotropic and Sigmatropic reactions. Woodward Hoffmann rules-The Mobius and Huckel concept- FMO- PMO method and correlation diagrams. Cycloaddition and retrocycloaddition reactions-[2+2]- [2+4]- [4+4]- Cationic-anionic- and 1-3-dipolar cycloadditions. Chelotropic reactions - Electrocyclization and ring opening reactions of conjugated dienes and trienes. Sigmatropic rearrangements: (1-3)- (1-5)- (3-3) and (5-5)-carbon migrations. Ionic sigmatropic rearrangements-Group transfer reactions-Regioselectivity- stereoselectivity and periselectivity in pericyclic reactions.	**18**

IV	**Organic Photochemistry-I:** Introduction - Thermal versus photochemical reactions - Photochemical excitation: Experimental techniques- electronic transitions -Jablonski diagrams -intersystem crossings- energy transfer processes. Photochemical reactions of ketones - photosensitization -Norrish type-I and type-II cleavage reactions-photooxidation and photo reduction of ketones-Paterno-Buchi reaction	**18**
V	**Organic Photochemistry-II:** Photochemistry of α-β-unsaturated ketones- cis-trans isomerization and Photo dimerisation. Photon energy transfer reactions- Photo Cycloaddition-Photochemistry of aromatic compounds- photochemical rearrangements- photo-stationery state- di-π-methane rearrangement- Reaction of conjugated cyclohexadienone to 3-4-diphenyl phenols-Barton reaction.	**18**
	Total	**90**

Self-study	Introduction to Retrosynthetic analysis

Textbooks:

1. Carey F. A. and Sundberg. 2003. *Advanced Organic Chemistry*, 5th Edition, Tata McGraw Hill. New York.
2. March. J and Smith. M. 2007. *Advanced Organic Chemistry*, 5th Edition, John Wiley and sons.
3. Ireland. R. E.1990. *Organic synthesis*, Prentice Hall India, Goel publishing house.
4. Clayden, Greeves, Warren, 2016. *Organic Chemistry*, 2nd Edition, Oxford University Press.
5. Smith M. B, 2011.*Organic Synthesis*, 3rd Edition, McGraw Hill International Edition.

Reference Books:

1. Gill and Wills.1974. *Pericyclic Reactions*, Chapman Hall, London.
2. Joule J.A. and Smith G.F. 2004. *Heterocyclic Chemistry*, Garden City Press, Great Britain.
3. Caruthers W.2007. *Some Modern Methods of Organic Synthesis*, 4th Edition, Cambridge University Press, Cambridge.
4. House. H. O.1972. *Modern Synthetic reactions*, W.A. Benjamin Inc.
5. Jagdamba Singh and Jaya Singh.2012. *Photochemistry and Pericyclic Reactions*, New Age International Publishers, New Delhi.

Web Resources:

1. https://rushim.ru/books/praktikum/Monson.pdf
2. http://tgc.ac.in/pdf/study-material/chemistry/Chemistry_Sem_IV_Honours Retrosynthetic_Analysis_1.pdf
3. https://www.frontiersin.org/articles/10.3389/fphy.2019.00100
4. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Spectroscopy/Electronic_Spectroscopy/Jablonsk
5. https://www.masterorganicchemistry.com/2020/06/26/electrocyclic-ring-opening-and-closure- 2-six-or-e

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**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO2	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CO5	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
TOTAL	**13**	**15**	**14**	**15**	**15**	**13**	**13**	**14**	**15**	**14**	**14**	**15**
AVERAGE	**2.6**	**3**	**2.8**	**3**	**3**	**2.6**	**2.6**	**2.8**	**3**	**2.8**	**2.8**	**3**

3 – Strong- 2- Medium- 1- Low

SEMESTER III

CORE COURSE VI: COORDINATION CHEMISTRY – I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CC2	6	-	-	-	5	6	90	25	75	100

Pre-requisite

Basic knowledge of inorganic chemistry

Learning Objectives

1. To gain insights into the modern theories of bonding in coordination compounds.
2. To learn various methods to determine the stability constants of complexes.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember the elementary aspects of crystal field theory and molecular orbital theory	**K1**
2.	understand the various theories of coordination compounds.	**K2**
3.	apply various experimental methods to determine the stability of complexes.	**K3**
4.	analyze the spectroscopic and magnetic properties of coordination complexes.	**K4**
5.	evaluate the mechanism of substitution reactions in octahedral and square planar complexes.	**K5**

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

Units	Contents	No. of Hours
I	**Modern theories of coordination compounds:** Crystal field theory - splitting of d orbitals in octahedral- tetrahedral and square planar symmetries - measurement of 10Dq - factors affecting 10Dq - spectrochemical series - crystal field stabilisation energy for high spin and low spin complexes- evidences for crystal field splitting – site selections in spinels and antispinels - Jahn Teller distortions and its consequences. Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields- Sigma and pi bonding in octahedral- square planar and tetrahedral complexes.	18
II	**Spectral characteristics of complexes:** Term states for d ions - characteristics of d-d transitions - charge transfer spectra - selection rules for electronic spectra - Orgel correlation diagrams - Sugano-Tanabe energy level diagrams - nephelauxetic series - Racha parameter and calculation of inter-electronic repulsion parameter.	18
III	**Stability and Magnetic property of the complexes:** Stability of complexes: Factors affecting stability of complexes- Thermodynamic aspects of complex formation- Stepwise and overall formation constants- Stability correlations- statistical factors and chelate effect- Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method- Potentiometric method- Spectrophotometric method- Ion exchange method- Polorographic method and Continuous variation method (Job's method) Magnetic property of complexes: Spin-orbit coupling- effect of spin-orbit coupling on magnetic moments-quenching of orbital magnetic moments.	18
IV	**Kinetics and mechanisms of substitution reactions of octahedral and square planar complexes:** Inert and Labile complexes; Associative- Dissociative and SNCB mechanistic pathways for substitution reactions; acid and base hydrolysis of octahedral complexes; Classification of metal ions based on the rate of water replacement reaction and their correlation to Crystal Field Activation Energy; Substitution reactions in square	18

	planar complexes: Trans effect- theories of trans effect and applications of trans effect in synthesis of square planar compounds; Kurnakov test.	
V	**Electron Transfer reactions in octahedral complexes:** Outer sphere electron transfer reactions and Marcus-Hush theory; inner sphere electron transfer reactions; nature of the bridging ligand in inner sphere electron transfer reactions. Photo-redox- photo-substitution and photo-isomerisation reactions in complexes and their applications.	**18**
	Total	**90**

Self- study	Molecular Orbital Theory and energy level diagrams concept of Weak and strong fields- Sigma and pi bonding in octahedral- square planar and tetrahedral complexes.

Textbooks

1. Huheey. J. E, Keiter, E. A, Keiter, R. L and Medhi, O. K,2006. *Inorganic Chemistry – Principles of structure and reactivity*, 4th Edition, Pearson Education Inc.
2. Meissler, G. L and Tarr, D. A, 2008. *Inorganic Chemistry*, 3rd Edition, Pearson Education Inc.
3. Bannerjea. D,1993. *Co-ordination Chemistry,* TATA McGraw Hill.
4. Figgis B. N, 1976. *Introduction to Ligand Fields*, Wiley Eastern Ltd.
5. Cotton, F. A, Wilkinson., G., Murillo, C. A, Bochmann, M, 1988. *Advanced Inorganic Chemistry,* 6th Edition, Wiley Inter-science: New York.

Reference Books:

1. Keith F. Purcell and John C. Kotz,1977. *Inorganic Chemistry*, Saunders Publications, USA.
2. Peter Atkins and Tina Overton, 2010. *Shriver and Atkins' Inorganic Chemistry*, 5th Edition, Oxford University Press.
3. Cotton F. A, Wilkinson G and Guas, P. L, 2002. *Basic Inorganic Chemistry*, 3rd Edition, John Wiley.
4. Douglas. B, McDaniel. D, Alexander. J, 1994. *Concepts and Models of Inorganic Chemistry,* 3rd Edition, John Wiley.
5. Cotton F. A, Wilkinson. G, Murillo C. A, Bochmann M,1988. *Advanced Inorganic Chemistry*, 6th Edition, Wiley Inter-science, New York.

Web Resources

1. https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall- 2008/pages/syllabus/
2. https://pubs.acs.org/doi/pdf/10.1021/bk-1994-0565.ch001
3. https://onlinelibrary.wiley.com/doi/full/10.1002/pssb.202200586
4. https://mgcub.ac.in/pdf/material/20200415030055bd7cfc2883.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	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 III

CORE LAB COURSE III: PHYSICAL CHEMISTRY PRACTICAL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233CP1	-	-	6	-	5	6	90	25	75	100

Pre-requisite:

Students should have the basic knowledge of physical chemistry.

Learning Objectives:

1. To understand the principle of conductivity experiments through conductometric titrations.
2. To evaluate the order of the reaction. temperature coefficient. and activation energy of the reaction by following pseudo first order kinetics.

Course Outcomes

On the successful completion of the course. students will be able to:		
1.	recall the basic theory of titrations and understand the principle of conductometric and potentiometric titrations	**K1 & K2**
2.	apply the principles of conductometry and potentiometry to determine the strength of unknown solutions.	**K3**
3.	analyze the strength of acids by adsorption method	**K4**
4.	evaluate conductance- dissociation constant and heat of solution	**K5**
5.	construct the phase diagram of two component system forming congruent melting solid.	**K6**

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

S. No	Contents	No. of Hours
I	**Conductivity Experiments** **1. Determination of equivalent conductance of a strong electrolyte & the verification of DHO equation.** **2. Verification of Ostwald's Dilution Law & Determination of pKa of a weak acid.** **3. Verification of Kohlrausch's Law for weak electrolytes.** **4. Determination of solubility of a sparingly soluble salt.** **5. Acid base titration (strong acid and weak acid vs NaOH).** **6. Precipitation titrations (mixture of halides only).**	**30**
II	**Kinetics** **1. Study the kinetics of acid hydrolysis of an ester. determine the temperature coefficient and also the activation energy of the reaction.** **2. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.**	**30**
III	**Phase diagram** Construction of phase diagram for a simple binary system 1. Naphthalene phenanthrene 2. Benzophenone diphenyl amine **Adsorption** Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).	**30**

	Total	**90**

Textbooks:

1. Viswanathan. V. B and Raghavan. P.S, 2009. *Practical Physical Chemistry*. Viva Books. New Delhi.
2. Sundaram, Krishnan and Raghavan, 1996. *Practical Chemistry (Part II*). S. Viswanathan Co. Pvt.
3. Athawale V.D. and Parul Mathur, 2008. *Experimental Physical Chemistry*. New Age International (P) Ltd., New Delhi.
4. Lewers E.G, 2011. *Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, 2nd Edition, Springer, New York.

Reference Books:

1. Yadav. J. B, 2001. *Advanced Practical Physical Chemistry*, Goel Publishing House.
2. Arland. G.W, Nibler. J.W, Shoemaker. D.P, 2009. *Experiments in Physical Chemistry*, 8th Edition, Mc Graw Hill.
3. Gurthu. J. N. and Kapoor. R.,1987. *Advanced Experimental Chemistry*- S. Chand and Co.
4. Shailendra K Sinha, 2014. *Physical Chemistry: A laboratory Manual*, Narosa Publishing House Pvt. Ltd., New Delhi.
5. Jensen. F, *Introduction to Computational Chemistry*, 3rd Edition, Wiley Black well.

Web Resources:

1. https://www.youtube.com/watch?v=nxvLWc_sI2I
2. https://www.nature.com/articles/s41597-023-01936-3
3. https://link.springer.com/article/10.1007/s10450-020-002589#:~:text=A%20batch%20adsorption%20experiment%20fromliquid%20at%20an%20initial%20concentration.
4. https://chem.libretexts.org/Ancillary_Materials/Laboratory_Experiments/Wet_Lab_Experiments/General_Chemistry_Labs/Online_Chemistry_Lab_Manual/Chem_12_Experiments/01%3A_Chemical_Kinetics_The_Method_of_Initial_Rates_(Experiment)
5. https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=850806

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	2	3	3	3	2
CO2	2	3	3	3	3	3	3	3	2	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	2	3
CO4	2	3	3	3	3	2	3	2	3	3	3	3
CO5	3	3	2	3	3	2	3	3	3	3	3	3
TOTAL	13	15	13	15	14	13	15	13	14	15	14	14
AVERAGE	2.6	3	2.6	3	2.8	2.6	3	2.6	2.8	3	2.8	2.8

3 – Strong- 2- Medium- 1- Low

SEMESTER III

CORE RESEARCH PROJECT

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233RP1	-	-	5	-	4	5	75	25	75	100

Pre-requisite: Practical Knowledge in Chemistry

Learning Objectives

1. To enable students to design experiment, analyze data and interpret results.
2. To develop skills to identify subject related problems in the neighborhood and report to the scientific community.

Course Outcome

Upon completion of this coursethe students will be able to:		
1.	understand new areas of research in Chemistry	**K2**
2.	apply research sources and tools to identify research problem	**K3**
3.	analyze the synthesized samples using various spectroscopic techniques	**K4**
4.	evaluate the results and findings of the research work	**K5**
5.	publish the research findings in reputed journals.	**K6**

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

Guidelines:

- All the students must undertake project work at the final year (III semester).
- The students, with the consent of the Supervisor, HOD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.

Distribution of marks for project

Internal: External = 25:75
Internal Components
Internal Viva= 5 marks
Regularity and Systematic work = 20 marks
External Components
Dissertation = 40 marks
Innovation= 10 marks
Presentation and Viva = 25 marks

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literature and objectives.	–	3rd Week of III Semester	–
I Review	5	July	Supervisor
II Review	5	August	Supervisor
Report	15	September/ October	Supervisor
Final–External (Dissertation andInnovation)	40	October /November	Ext. examiner
* Final– Project Viva (group & open)	35	October /November	Ext. examiner
Total marks	100		

*Mode of presentation by Power Point

Project framework

The Project format should be in:

- Font – Times New Roman
- Heading – Font size 14 (Bold) – Uppercase
- Sub headings – Font size 12 (Bold) — Lowercase;
- should be numbered. (Eg: Introduction 1; Subheading 1.1; 1.2)
- Text, the content of the dissertation — Font size – 12 (Normal).
- Citation – Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designated by the name of the *fast* author followed by the year of publication, placedinside brackets at the appropriate places in the text.

ii) A paper, a monograph or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

A paper, a monograph or a book with more than two authors may be designated by the name of the first author followed by et al, and the yearof publication, placed inside brackets at the appropriate places in the text.

- Line space – 1.5
- Margin – 2" on the left and 1" on the right, Gutter – 0.5.
- Page Numbering — Bottom middle alignment; excluding initial pages andreference
- Total number of pages – Minimum 30 – Maximum 50

(excluding initial pages and reference).

- The Tables and Figures should be included subsequently after referring them in the text of the Report.

II. Project Report must be completed within the stipulated time.

III Submission of Project Report:

- one soft copy (PDF format in CD)
- three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The Project Report will have three main parts:

Initial Pages – in the following sequence

i. Title Page
ii. Certificate from the Supervisor
iii. Declaration by the candidate endorsed by the Supervisor and HOD
iv. Acknowledgement (within one page – signed by the candidate).
v. Table of Contents
vi. List of abbreviations

Abstract

II. Main body of the dissertation

i) Introduction with Literature review and Objectives

ii) Methodology
iii) Results
iv) Discussion
v) Summary
vi) References

The guidelines for reference
Journal Article: with Single Author
Waldron, S 2008. "*Generalized Welch bound equality sequences are tight frames*",IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307– 2309.
Journal Article: with Two Authors
Conley, TG & Galeson, DW 1998. "*Nativity and wealth in mid– nineteenth centurycities*", Journal of Economic History, vol. 58, no. 2, pp. 468– 493.
Journal Article: with more than two Authors
Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009. *Bounds on the sum capacity of synchronous binary CDMA channels*, Journal of Chemical Education, vol. 55, no. 8, pp. 3577– 3593.
Books
Holt, DH 1997. *Management Principles and Practices*, Prentice– Hall, Sydney. Centre for Research, M S University -Ph.D. Revised Guidelines, Page: 39 / 41
E– book

Aghion, P &Durlauf, S (eds.) 2005. *Handbook of Economic Growth*, Elsevier,,Amsterdam. Available from: Elsevier books.

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**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**
CO5	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**
TOTAL	**13**	**14**	**13**	**14**	**13**	**15**	**12**	**13**	**14**	**12**	**13**	**12**
AVERAGE	**2.6**	**2.8**	**2.6**	**2.8**	**2.6**	**3**	**2.4**	**2.6**	**2.8**	**2.4**	**2.6**	**2.4**

3 – Strong- 2- Medium- 1- Low

SEMESTER III

ELECTIVE COURSE V: a) RESEARCH TOOLS AND TECHNIQUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite

Basic knowledge of research methodology.

Learning Objectives

1. To motivate the students for research-based studies.
2. To explore relationships between variables and interpret research findings accurately.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember the information gathered from diverse sources in research.	**K1**
2.	understand the advanced search strategies and analytical techniques relevant to research topics.	**K2**
3.	apply the research tools and techniques for advance research and development.	**K3**
4.	analyze the scientific data from diverse sources in research.	**K4**
5.	evaluate the scientific output to interpret the research findings.	**K5**

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

Units	Contents	No. of Hours
I	**Source of chemical information** Primary - secondary and tertiary sources. Literature survey - indexes and abstracts in science and technology. Applied science and technology index - chemical abstracts - chemical titles - current chemical reactions - current contents and science citation index. Classical and comprehensive reference works in chemistry-synthetic methods and techniques - treatises - reviews - monographs. Access points for searching CA indexes- index guide - general subject - terms - chemical substance names - molecular formulas - ring systems - author names - patent numbers. Locating the reference - finding the abstract - finding the original document chemical abstract and service source index.	12
II	**Research Problem and Scientific Writing** Identification of research problem - assessing the status of the problem - guidance from the supervisor - actual investigation and analysis of experimental results - conclusions. Scientific writing - research reports - thesis - journal articles and books. Steps to publishing a scientific article in a journal. Types of publications - communications - articles and reviews. Documenting - Abstracts indicative - descriptive abstracts - informative abstract - footnotes - end notes - referencing styles - bibliography - journal abbreviations - abbreviation used in scientific writing.	12
III	**Instrumental Analysis** Principle - instrumentation and applications - AFM - SEM - STM - TEM and XRD. Determination of surface morphology and particle size. Sample preparations and applications of UV - IR - NMR and mass spectroscopy.	12
IV	**Cheminformatics** Cheminformatics - history and applications. Representing molecules - connection tables and line notation - Inchi - SMILES and WLN canonicalization. Line notation versus connection tables. Query languages	12

	- SMARTS. Molecular similarity. 2D topology and 3D configuration. Chemistry softwares - Chemdraw - writing chemical equations and schemes - editing - transporting picture to word and image document. Origin -importing and exporting data - scientific graphing and data analysis - curve fitting and peak analysis - transporting graph to tag image file format.	
V	**Intellectual Property Rights** Introduction to Intellectual Property Rights- Components of Intellectual Property-Patents-Trademarks-Copyrights-Trade Secrets-Industrial designs and Geographical Indications (GI)-The Patent's act 1970- -Protectable Subject Matter patentable invention-- patent Infringement and enforcement of patents- -Action for Infringement- - Brief Discussion on Case Law on Patents.	**12**
	Total	**60**

Self-study	Sources of information: primary- secondary and tertiary sources

Textbooks:

1. Berg- B.L. 2009. *Qualitative Research Methods for the Social Sciences,* 7th Edition, Pearson Education Inc., USA.
2. Patton, M.Q.2002. *Qualitative research and evaluation methods,* 3rd Edition, India: Sage Publications.
3. Mohan. J, 2001. *Organic Spectroscopy Principles and Applications*, Narosa publishing house, India.
4. Maidasane. D, 2005. *Learning Computer Fundamentals,* MS Office and Internet and Web Technology, New Delhi: Firewall media.

Reference Books:

1. Silverman D., 2011. *Qualitative Research: Issues of Theory, Method and Practice,* 3rd Edition, Sage Publications, India.
2. Marczyk. G, Dematteo. D and Festinger. D, 2005. *Essential of Research Design and Methodology*, John Wiley and Sons, New York.
3. Vogel A.I. 1978. *A Text Book of Quantitative Inorganic Analysis*, 4th Edition, New York: Longman.
4. Gasteiger J. and Engel. T, 2003.*Cheminformatics*, New York: Wiley.
5. Polanski J. 2009. *Cheminformatics*. Elsevier Publications, Poland.
6. Marczyk. G. Dematteo. D. & Festing. D. 2005. *Essential of Research Design and Methodology*, John Wiley and Sons, New York.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037943/
2. https://www.coursera.org/articles/statistical-analytics
3. https://www.studysmarter.co.uk/explanations/chemistry/chemical-analysis/instrumental- analysis/
4. http://www.researchmanuscripts.com/September2017/6.pdf
5. https://www.sciencedirect.com/topics/chemistry/chemoinformatics

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 III

ELECTIVE COURSE V: b) PHARMOCOGNOSY AND PHYTOCHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic knowledge of organic chemistry

Learning Objectives:

1. To develop the knowledge of natural products- biological functions and pharmacological uses.
2. To develop knowledge on primary and secondary metabolites and their sources.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall the sources of natural medicines and analysis of crude drugs.	**K1**
2.	understand the methods of evaluation based on various parameters.	**K2**
3.	apply various techniques to discover new alternative medicines.	**K3**
4.	analyze the isolated drugs	**K4**
5.	evaluate the isolated drugs for various pharmacological activities	**K5**

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

Units	Contents	No. of Hours
I	**Pharmacognosy and Standardization of Herbal drugs:** Introduction- definition- development classification and Source of Drugs: Biological- mineral- marine and plant tissue cultures. Study of pharmacognostic of a crude drug. Biosynthesis: Shikimic acid pathway and acetate pathway. Systematic analysis of Crude drugs. Standardization of Herbal drugs. WHO guidelines- Sampling of crude drug- Methods of drug evaluation. Determination of foreign matter- moisture Ash value. Phytochemical investigations-General chemical tests.	12
II	**Extraction Techniques:** General methods of extraction- types – maceration- Decoction- percolation- Immersion and soxhlet extraction. Advanced techniques- counter current- steam distillation- supercritical gases- sonication- Micro waves assisted extraction. Factors affecting the choice of extraction process.	12
III	**Drugs containing Terpenoids and volatile oils:** Terpenoids: Classification- Isoprene rule- Isolation and separation techniques- General properties Camphor- Menthol- Eucalyptol. Volatile Oils or Essential Oils: Method of Preparations- Classifications of Volatile oils- Camphor oil- Geranium oil- Citral- Structure uses. Pentacyclic triterpenoids: amyrines; taraxasterol: Structure and pharmacological applications.	12
IV	**Drugs containing alkaloids:** Occurrence- function of alkaloids in plants- pharmaceutical applications. Isolation- Preliminary Qualitative tests and general properties. General methods of structural elucidation. Morphine- Reserpine- papaverine - chemical properties- structure and uses. papaverine - structure- chemical properties and uses.	12
	Plant Glycosides and Marine drugs: Glycosides: Basic ring system- classification- isolation- properties- qualitative analysis. Pharmacological	

V	activity of Senna glycosides- Cardiac glycosides -Digoxin- digitoxin- Steroidal saponins glycosides- Diosgenin- hecogenin. Plant pigments: Occurrence and general methods of structure determination- isolation and synthesis of quercetin and cyanidin chloride. Marine drugs -Selected Drug Molecules: Cardiovascular active substances- Cytotoxic compounds- antimicrobial compounds- antibiotic compounds- Anti-inflammatory agents. Marine toxins.	**12**
	Total	**60**

Self-study	Introduction about Medicinal plants

Textbooks:

1. Gurdeep R Chatwal, 2016. *Organic chemistry of Natural products,* Volume I & II, 5th Edition, Himalaya publishing House.
2. Bhat. S.V, Nagasampagi B.A and Sivakumar. M, 2014. *Chemistry of Natural Products*, Revised Edition, Narosa Publishers.
3. Carruthers W, 2015. *Modern Methods of Organic Synthesis*, 4th Edition, Cambridge University Press.
4. Finar. I.L, 2002. *Organic Chemistry*, Volume II, 5th Edition, India: Pearson Education.
5. Patrick J. Sinko, 2016. *Martin's Physical Pharmacy and Pharmaceutical Sciences*, 7th Edition, Lippincott Williams and Wilkins Publishers.

Reference Books:

1. Jeffrey B. Harborne, 2012. *Phytochemical methods: A Guide to Modern Techniques of Plant Analysis*, 4th Edition, Indian reprint, Springer.
2. Ashutoshkar, 2007. *Pharmacognosy and Pharmacobiotechnology*, 2nd Edition, New age international (P) limited, New Delhi.
3. Papon. N, Copp. B.R. and Courdavault V, 2022. *Biotechnology Advances*, 54, p.107871.
4. Clayden J. Greeves, N & Warren. S., 2012. *Organic Chemistry*, 2nd Edition, Oxford University Press**.**
5. Agarwal. O.P, 1947. *Chemistry of Organic Natural Product*- Vol. I& II- India: Goel Publishing House.

Web Resources:

1. https://www.researchgate.net/publication/342169788_Pharmacognostic_study_data_of_Indian_medicinal_plants
2. https://www.phcogrev.com/sites/default/files/PhcogRev-1-1-7.pdf
3. https://www.centaurpharma.com/downloads/2021/entchestphysician/cold/Sinarest%20vapo caps.pdf
4. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004131501351340nkkhare_Al kaloids.pdf
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8576406/

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	3	2	3	3	3	3	2	3
CO2	3	2	3	2	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	2	3	3	3	3	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	2	3
TOTAL	**14**	**14**	**15**	**14**	**15**	**13**	**14**	**15**	**13**	**14**	**13**	**14**
AVERAGE	**2.8**	**2.8**	**3**	**2.8**	**3**	**2.6**	**2.8**	**3**	**2.6**	**2.8**	**2.6**	**2.8**

3 – Strong- 2- Medium- 1- Low

SEMESTER III

ELECTIVE COURSE V: c) SURFACE CHEMISTRY AND CATALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic knowledge of chemical kinetics

Learning Objectives:

1. To develop an understanding of the concept of homogeneous catalysis and its significance.
2. To understand and use adsorption isotherms for mono and multilayer adsorption on porous solid surfaces.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall and understand the definitions, basics of surface, interfacial phenomena, catalysis, colloids and surface characterization.	**K1 & K2**
2.	apply homogeneous and heterogeneous catalysis- photo and bio catalysis-express the properties of colloids and classify surface analytical tools.	**K3**
3.	analyze the mechanism involved in various catalysis and principles of conventional and spectroscopic surface characterization techniques.	**K4**
4.	evaluate the importance of the characteristics of surface- interfacial phenomena- colloids a limitations of surface analytical techniques.	**K5**
5.	develop analytical skills in interpreting the results of surface analytical tools and to choose the appropriate among homogeneous- heterogeneous- photo and bio catalyst for industrial applications and research.	**K6**

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

Units	Contents	No. of Hours
I	**Enzyme Catalysis:** Catalysis phenomenon – mode of action of catalysts – classification of catalysts – Comparison of Homogeneous and Heterogeneous Catalysis. Homogeneous catalysis – general mechanisms; acid-base catalysis – catalytic activity- mechanisms and salt effects. Enzyme catalysis – influence of substrate concentration- pH- temperature- transient phase kinetics and enzyme mechanisms. Kinetics of inhibition –chain reaction- enzyme catalyzed reactions.	12
II	**Industrial catalysis**: Catalysis in molecular-scale cavities – structure of crystalline solids – zeolites – families of zeolites; adsorption and diffusion in zeolites – catalysis by zeolites containing metal complexes and clusters; non-zeolite molecular sieves – clays and other layered materials. Catalysis – catalysts for PTC – mechanism and benefits of PTC – PTC reactions – selected industrial processes with PTC.	12
III	**Micellar catalyst**: Micellar catalysis: effects of micelles on chemical reactions- characteristics of enzymatic reactions- micelle-catalyzed reactions- inhibition in micellar solutions; reverse micelles and microemulsions – catalysis in thermal and photochemical reactions.	12
IV	**Electrocatalyst:** Electrocatalysis – introduction to electrocatalysis and fuel cells – industrial application of catalysis – petroleum refining – distillation- cracking- reforming- hydrotreating- Alkylation and isomerization- steam cracking- ethylene-	12

	based processes – ethylene oxide and ethylene glycol- polyethylene- vinyl chloride and PVC; Propylene-based processes – acrylic acid and acrylonitrile- Ziegler-Natta chemistry; C$- based processes – butadiene- isobutylene.	
V	**Surface catalyst:** Surface catalysis – introduction – mechanism of surface reactions: Langmuir- Hinshelwood & -Rideal mechanisms; surface structures – single crystal surface of metals- high-surface area amorphous solids; adsorption; functionalized surfaces; catalysis on functionalized surfaces: connection to molecular catalysis; catalysis on metal surfaces- metal oxide surfaces- supported metals- mixed metal oxides- metal sulfides (minimum of one example for each).	**12**
	Total	**60**

Self-study	Basic concepts of catalyst

Textbooks:

1. Gates. B. C, 1992. *Catalytic Chemistry*, John Wiley & Sons- Inc.
2. Kuriacose. J. C, 1991. *Catalysis*, Macmillan India Ltd., New Delhi.
3. Viswanathan. B- Sivasanker. S and Ramaswamy A.V- 2010. *Catalysis: Principles and Applications*, Narosa Publishing House, New Delhi.
4. Viswanathan. B, Kannan. S and Deka. R. C, 2004. *Catalysts and surfaces characterization techniques*, Narosa Publishing House, New Delhi.
5. Chakrabarthy. D. K. and Viswanathan. B, 2011. *Heterogeneous catalysis*, New Age International (P) Limited Publishers, New Delhi.

Reference Books:

1. Kalyanasundaram. K, 1987. *Photochemistry in Microheterogeneous Systems*, Academic Press, Orlando.
2. Laidler. K. J, 2005. *Chemical Kinetics*, 3rd Edition, Pearson Education Pvt. Ltd.
3. Murugesan. V, Banumathi. A and Palanichamy. M, 1999. *Recent Trends in Catalysis*, Narosa Publishing House, New Delhi.
4. Chakrabarthy. D. K, 2008. *Adsorption and catalysis by solids*, New Age International (P) Limited Publishers, New Delhi.
5. Hagen. J, 2006. *Industrial Catalysis: A Practical Approach*, 2nd Edition, Wiley, VCH.

Web Resources:

1. https://bit.ly/3HDzsPz
2. https://go.nasa.gov/3y9WBWU
3. https://bit.ly/3bgprLW
4. https://bit.ly/3n5y9zj
5. https://nptel.ac.in/courses/113/104/113104004/

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	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	2	2
CO4	3	3	3	3	2	3	3	2	3	2	3	3
CO5	2	3	2	3	3	3	2	3	3	2	3	2
TOTAL	13	14	13	14	13	15	12	13	14	12	13	12
AVERAGE	2.6	2.8	2.6	2.8	2.6	3	2.4	2.6	2.8	2.4	2.6	2.4

3 – Strong- 2- Medium- 1- Low

SEMESTER III

SKILL ENHANCEMENT COURSE II: CHEMICAL ANALYSIS - TOOLS AND TECHNIQUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233SE1	3	1	-	-	2	4	60	25	75	100

Pre-requisites:

Students should know the basic skills of Analytical Chemistry

Learning Objectives:

1. To understand the principles and importance of food preservation.
2. To execute analytical techniques accurately, interpret results and prepare comprehensive reports based on findings.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the chemical analysis procedures effectively, including sample collection, preparation, analysis, interpretation of results, and report writing.	**K1&K2**
2	apply separation and purification techniques to isolate and purify substances based on their physical and chemical properties.	**K3**
3	analyze and interpret experimental data obtained from analysis, physical properties determination, and separation techniques	**K4**
4	evaluate the importance of food preservation techniques and apply appropriate methods for preserving food products	**K5**
5	collaborate effectively with peers in laboratory settings, demonstrating teamwork and communication skills.	**K6**

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

Units	Contents	No. of Hours
I	**Chemical Analysis** Definition- collection of samples- selection of appropriate analytical method- preparation of the sample- analysing the sample using the selected method- technique- interpreting the results- report preparation.	12
II	**Food Preservation Techniques** Food preservation- techniques of food preservation-chemical and physical methods- importance of food preservation-food preservatives and food packing.	12
III	**Quantitative Analysis** Titration- Definition and difference between qualitative and quantitative analysis- types of titrations-end point-equivalence point. Indicators-types-oxidizing and reducing agents- gravimetric analysis- detailed description of the steps of gravimetric analysis-applications.	12
IV	**Physical Properties of Liquids** Physical states of matter- melting point, determination of melting point- decomposition-evaporation-sublimation. Boiling point- determination of boiling point.	12
	Separation and Purification Techniques Characterization-uses and selection of separation process-filtration techniques-filter	12

V	paper-simple filtration-filtration through vacuum pump-distillation- types of distillation-simple distillation-fractional distillation-difference between simple and fractional distillation.	
	Total	**60**

Self-study	Basic skills of Analytical Chemistry

Textbooks

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 Edition, India: Prentice Hall.
3. Chatwal, G.R. &Anand, S.K. 2002. *Instrumental Methods of Chemical Analysis*, 5th Edition, India: Himalaya Publishing House.
4. Ditts, R.V. 1974. *Analytical Chemistry-Methods of Separation*, New York van Nostrand.
5. D. A. Skoog, D. M. West and F. J. Holler, 1996. *Fundamentals of Analytical Chemistry*, 7th Edition, Saunders College Publishing.

Reference Books

1. Christian, G.D. 2007. *Analytical Chemistry*, 6th Edition, New York: John Wiley & Sons.
2. Douglas A. Skoog, James Holler, F. and Stanley R. Crouch, 2018. *Principles of Instrumental Analysis*, 7th Edition, Australia: Thompson Brooks/Cole.
3. Harris D. C and Freeman W.H., 2004. *Exploring Chemical Analysis*, Ed. New York.
4. Puri. B. R., Sharma L. R. and Pathania M. S., 2019. *Principles of Physical Chemistry*,
5. 48th Edition, Vishal Publishing Co.
6. Pomeranz Y., Meloan C. E., 2000. *Food Analysis: Theory and practice*, Springer.

Web Resources

1. https://www.studysmarter.co.uk/explanations/chemistry/chemical-analysis/
2. https://www.britannica.com/science/chemical-analysis/Samplereparation
3. https://microbiologynote.com/methods-of-food preservation/
4. https://biologyreader.com/food-preservation-techniques.html
5. https://byjus.com/jee/titration/

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	3	3	3	3	2	3	2
CO3	3	3	2	3	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	2	2	3
TOTAL	**13**	**15**	**14**	**14**	**13**	**14**	**14**	**13**	**14**	**13**	**13**	**13**
AVERAGE	**2.6**	**3.0**	**2.8**	**2.8**	**2.6**	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**2.6**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE-ADDED COURSE: FOOD PRESERVATION AND TECHNOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233V01	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic knowledge of food preservation technology.

Learning Objectives:

1. To introduce the basics of various food processing and preservation technologies.
2. To make the students aware of the standards of food quality

Course Outcomes

On the successful completion of the course. students will be able to:		
1	recall the fundamental concepts of food preservation.	**K1**
2	understand the principle of food preservation methods.	**K2**
3	apply various methods for preserving food	**K3**
4	analyze the reasons for spoilage of foods	**K4**
5	measure the nutritive value of different foods.	**K5**

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

Units	Contents	No. of Hours
I	**Food Preservation** Principle of food preservation--removal of microorganism - maintenance of anaerobic conditions-general principles underlying spoilage-chemical changes caused by microorganisms - spoilage of different kinds of foods-intrinsic and extrinsic Parameters that affect microbial growth.	6
II	**Heat Preservation and Processing** Heat preservation and processing-degrees of preservation selecting heat treatments-Heat resistance of Microorganisms-heat transfer-protective effects of food contamination-cold preservation and processing - distinction between refrigeration and freezing-refrigeration and cold storage-freezing and frozen stage-different methods of drying process-food dehydration-food concentration-food irradiation-microwave heating and ohmic heating	6
III	**Processed food adulteration** Milk and milk products-meat and meat products-cereals and cereal products- sugar and sugar products-canned foods and bottled beverage-fruit and vegetable products-fruit juices-jams-marmalades-squashes-cordials-ketchup - sauces-soup Powder.	6
IV	**Food adulteration** Definition of food adulteration-importance of food safety and quality- types of food adulteration - intentional adulteration-incidental contamination-common adulterants in food- chemical adulterants- biological adulterants - physical adulterants.	6
V	**Detecting adulteration** Detection Methods - chemical analysis techniques (e.g., chromatography, spectroscopy) - microbiological tests - physical examination methods (e.g., microscopy, sensory evaluation)-international regulations and standards (e.g.,	6

	Codex Alimentarius, EU regulations) - national food safety agencies and their roles -legal consequences of food adulteration.	
	Total	**30**

Self-study	Definition of food adulteration-importance of food safety and quality- common adulterants in food- chemical adulterants- biological adulterants - physical adulterants .

Textbooks:

1. Srilakshmi. B, 2002. *Food Preservation and Safety: Principles and Practice*, New Age Publishers.
2. Meyer, 2004. *Food Chemistry*, New Age.
3. Bawa. A.S and Chauhan. O. P, 2013. *Food Science*, New India Publishing agency.
4. Frazier WC and Westhoff DC, 2004. Food Microbiology, TMH Publication, New Delhi.
5. Desrosier NW and Desrosier JN, 1998. The Technology of Food Preservation, CBS Publication, New Delhi.

Reference Books:

1. Paine. F. A and Paine H. Y, 1992. *Handbook of Food Packaging*, Thomson Press India Pvt Ltd, New Delhi.
2. Potter NH, 1998. *Food Science*, CBS Publication, New Delhi.
3. Ramaswamy. H and Marcott. M, 2006. *Food Processing Principles and Applications*, CRC Press.
4. Rao P. G, 2010. *Fundamentals of Food Engineering*, PHI Learning Pvt Ltd, New Delhi.
5. Toledo Romeo T, 1999. *Fundamentals of Food Process Engineering*, Aspen Publishers.

Web Resources:

1. https://www.routledge.com/Food-Processing-and-Preservation-Technology-Advances-Methods-and-Applications/Goyal-Mishra-Birwal/p/book/9781771889957
2. https://www.taylorfrancis.com/books/edit/10.1201/9781003153184/food-processing-preservation-technology-megh-goyal-santosh-mishra-preeti-birwal
3. https://www.cold.org.gr/library/downloads/Docs/Handbook%20of%20Food%20Preservation.PDF
4. https://onlinecourses.nptel.ac.in/noc22_ag03/preview
5. https://www.researchgate.net/publication/357335464_Review_Article_on_Traditional_and_Modern_Techniques_For_Food_Preservation

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	3	2	3	3	3	3	2	3
CO2	3	3	3	2	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	2	3	3	3	2	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	2	3
TOTAL	**14**	**15**	**15**	**14**	**14**	**13**	**14**	**15**	**13**	**14**	**13**	**14**
AVERAGE	**2.8**	**3**	**3**	**2.8**	**2.8**	**2.6**	**2.8**	**3**	**2.6**	**2.8**	**2.6**	**2.8**

3 – Strong- 2- Medium- 1- Low

SEMESTER III

SPECIFIC VALUE-ADDED COURSE: PAINTS AND COATINGS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233V02	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic knowledge of paints and coatings.

Learning Objectives:

1. Gain comprehensive knowledge of the composition, structure, and properties of paints and coatings.
2. Explore advanced topics such as nanotechnology, smart coatings, and sustainable practices in the paint and coatings industry.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	understand the principles underlying the formulation and manufacturing processes of paints	**K1 & K2**
2.	apply the extraction techniques in herbal drug formulation.	**K3**
3.	analyze the practical applications and challenges in the field	**K4**
4.	evaluate the environmental impact of paints and coatings and explore strategies for sustainable development.	**K5**
5.	develop proficiency in surface preparation techniques and paint application methods.	**K6**

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

Units	Contents	No. of Hours
I	**Introduction to Paints and Coatings:** Definition and classification of paints and coatings - Historical development and evolution of paint technology -Role and importance of paints and coatings in various industries. Basic components of paints: binders – pigments – solvents and additives. Functions of each component in paint formulation. Types of binders: oil-based, water-based, and solvent-based. Pigment dispersion techniques and selection criteria for pigments	**6**
II	**Properties of Paints:** Physical properties: viscosity - rheology - surface tension and drying characteristics. Chemical properties: resistance to corrosion - chemicals - UV radiation and weathering. Mechanical properties: adhesion, hardness, flexibility, and impact resistance.	**6**
III	**Overview of paint manufacturing methods:** Batch - semi-batch- and continuous processes. Mixing – dispersion - milling, and blending techniques. Quality control measures and testing protocols for raw materials and finished products.	**6**
IV	**Types of Coatings:** Architectural coatings - interior and exterior paints, primers, and varnishes. Industrial coatings: protective coatings for metal, concrete, and wood surfaces. Specialty coatings: automotive coatings, marine coatings and powder coatings. Surface preparation methods: cleaning - sanding and priming. Application Techniques: Brushing- rolling- spraying and dipping techniques. Factors influencing paint application: temperature – humidity and substrate condition	**6**
V	**Environmental and Health Considerations:** Environmental impact of paints: volatile organic compounds (VOCs) - hazardous air pollutants (HAPs) and waste disposal - Regulations and standards governing the use of paints and coatings - Sustainable	**6**

	practices and alternative technologies in paint manufacturing - Future Trends and Innovations - Emerging technologies in paint formulation and application	
	Total	**30**

Self-study	Introduction – Classification of paints and coatings

Textbooks

1. Lambourne.R and Strivens, TA,1999. *Paint and Surface Coatings: Theory and Practice* Woodhead Publishing,Cambridge, UK.

2. Arthur A. Tracton, 2006.*Coatings Technology Handbook*,CRC Press, Boca Raton, Florida, USA.

3. Joseph V. Koleske, 1995. *Paint and Coating Testing Manual*, ASTM International, West Conshohocken, Pennsylvania, USA

4. Kulkarni. JV. 2010. *Chemistry and Technology of Paints*, Nirali Prakashan, Pune, India

5. Peter A. Lewis, 1988. *Pigment Handbook*, Wiley, New York, USA.

Reference Books

1. David H. West and Mark G. Smith, 1997. *Understanding Paint Technology,* Springer, Dordrecht, Netherlands.

2. Lucas F. M. da Silva, Andreas Öchsner, and Robert D. Adams, 2011. *Handbook of Adhesion Technology*, Springer, Berlin, Germany

3. Raymond F. Wegman and James W. Kahl, 2011. *Surface Preparation Techniques for Adhesive Bonding*, William Andrew, Norwich, New York, USA.

4. Nalwa, HS, 2013. *Nanotechnology in Coatings: A Practical Guide for Coatings Formulators*, American Scientific Publishers. Valencia, California, USA.

5. Carlos M. Sperling and Mário V. D. Quiroga, 2012. *Environmental and Health Impact of Coatings*, CRC Press, Boca Raton, Florida, US

Web Resources

1. https://www.paint.org/
2. https://www.european-coatings.com/
3. https://www.coatingstech.org/
4. https://www.paintsquare.com/
5. https://www.coatingspromag.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	3	2	3	3	3	3	2	3
CO2	3	3	3	2	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	3	3	2	3	3	2
CO4	2	3	3	3	2	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	2	3
TOTAL	**14**	**15**	**15**	**14**	**14**	**13**	**14**	**15**	**13**	**14**	**13**	**14**
AVERAGE	**2.8**	**3**	**3**	**2.8**	**2.8**	**2.6**	**2.8**	**3**	**2.6**	**2.8**	**2.6**	**2.8**

3 – Strong- 2- Medium- 1- Low

SEMESTER III

SELF LEARNING COURSE: PETROCHEMICALS AND COSMETICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP233SL1	-	-	-	-	1	-	-	25	75	100

Pre-requisite:

Basic knowledge of petrochemicals and cosmetics.

Learning Objectives

1. To identify key chemical processes involved in petrochemical production.
2. To comprehend the diverse applications of hydrocarbons in various industries.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand the common substances and products within the field of petrochemistry and cosmetics.	**K1**
2.	understand the data and diagrams illustrating the structures and properties of organic compounds used in perfumes and cosmetics.	**K2**
3.	analyze the impact of environmental regulations and market trends on the petrochemical industry.	**K3**
4.	apply the knowledge of petrochemical processes to analyze real-world examples of fuel production, petroleum refining, and industrial organic synthesis.	**K4**
5.	generate innovative ideas for improving the efficiency and sustainability of cosmetic production processes.	**K5 &K6**

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

Units	Contents
I	**Introduction to petrochemistry:** Introduction – Petroleum – Refining of crude oil – Fuels for internal combustion engines. Knocking, Octane number. Unleaded petrol. Diesel Engine and Cetane number. Cracking – Thermal, Catalytic. Mechanism of cracking process. Reforming Activation Gasoline. Petrochemicals
II	**Hydrocarbons from Petroleum**: Introduction. Raw materials. Saturated hydrocarbons from natural gas. Uses of saturated hydrocarbons. Unsaturated hydrocarbons – Acetylene, Ethylene, Propylene, Butylenes. Aromatic hydrocarbons - Benzene. Toluene. Xylenes. Chemical processing of paraffin hydrocarbons. Chemical processing of ethylene hydrocarbons. Chemical processing of acetylene. Chemical processing of aromatic hydrocarbons.
III	**Petroleum Products**: Introduction. Classification of petroleum products. Liquefied hydrocarbons, gases and fuels. Fuel oils or boiler oils. Fuel for Jet engines and gas turbine engines. Lubricants, products of oil paraffine processing and other petroleum products. Lubricating and other oils. Paraffins, ceresins, petroleum. Miscellaneous petroleum products. Products of petrochemical and basic organic synthesis. Dye intermediates. Lacquers. Solvents. Thinners.
IV	**Industrial Organic Synthesis**: Introduction. The raw materials and basic processes. Chemical process used in industrial organic synthesis. Petrochemicals- Methanol. Important points. Ethanol. Important points. Rectified spirit from beer. Methylated spirit. Proof spirit. Preparation of the absolute alcohol from rectified spirit. Acetaldehyde. Acetic acid. Isopropanol. Ethylene glycol. Glycerine. Acetone. Phenol. Formaldehyde. Important points.

	Ethyl acetate. Important points
V	**Perfumes and Cosmetics**: Perfumes: Introduction. Esters. Alcohols. Ketones. Ionones. Nitromusks. Aldehydes. Diphenyl compounds. Production of natural perfumes. Flower perfume. Fruit flavours. Artificial flavours. Cosmetics: Introduction. Toothpaste. Ingredients. Preparation. Recipe for toothpaste. Shampoos. Ingredients. Recipe. Hair dyeing. Materials used. Colour and Curl of Hair. Creams and Lotions. Skin Chemicals. Their ingredients. Preparation and recipe. Lipsticks. Ingredients. Preparation and recipe. Perfumes, Colognes and after shave preparation. Compounds with flowery and fruity odours used in perfumes with their structures. Compounds with unpleasant odours used to fix delicate odours in perfumes. Deodorants and Antiperspirants. Cosmetics: Economics and Advertising.

Textbooks

1. Ertl. G., Knozinger. H and Weitkamp. J,1997. *Handbook of Heterogeneous Catalysis*, Vol 1-5, Wiley-VCH, Weinheim.
2. Farrauto. R. J and Bartholomew. C. H., 1997. *Fundamentals of Industrial Catalytic Processes*, Blackie Academic and Professional – Chapman and Hall.
3. Pearce. R and. Patterson. W. R, 1981. *Catalysis and chemical processes*, Academic press, Leonard Hill, London.

Reference Books

1. William L. Leffler, 2000. *Petroleum Refining in Nontechnical Language,* 4th Edition, PennWell Books.
2. James G. Speight, 2016. *Introduction to Petroleum Exploration and Production*, Wiley.
3. Robert A. Meyers, 2003. *Handbook of Petroleum Refining Processes*, McGraw-Hill Education.
4. Snyder, L. R., Kirkland, J. J. and Dolan, J. W., 2010. *Introduction to Modern Liquid Chromatography*, Wiley.
5. Baki, Antonella, and Robert Y. Lochhead, 2017. *Cosmetic Science and Technology: Theoretical Principles and Applications,* CRC Press.

Web resources

1. https://www.google.com/url?sa=i&url=https%3A%2F%2Fdduchemical.files.wordpress.com%2F2015%2F12%2Fpetrochemicals.pdf&psig=AOvVaw38fbY35RN7VcBKnTt4fbWE&ust=1716227928655000&source=images&cd=vfe&opi=89978449&ved=0CAgQr5oMahcKEwiY19-3pZqGAxUAAAAAHQAAAAAQBw
2. https://health.hawaii.gov/about/files/2021/12/21.12.16_What-Are-Petroleum-Hydrocarbons.pdf
3. https://www.sciencedirect.com/topics/engineering/petroleum-product
4. https://uclouvain.be/en-cours-2021-lchm2245.pdf
5. https://www.sciencedirect.com/science/article/pii/B9780444826541500065

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO	PO	PO	PO	PSO	PSO	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 IV

CORE COURSE VII: COORDINATION CHEMISTRY – II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Basic knowledge of inorganic chemistry

Learning Objectives:

1. To remember the fundamental concepts and understand the structural aspects of coordination compounds.
2. To study the reactions and catalytic behaviour of organometallic compounds.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall the fundamental concepts and understand the structural aspects of coordination compounds.	**K1 & K2**
2.	apply the concepts and mechanisms to study the structure and bonding in inorganic compounds.	**K3**
3.	analyze and predict the structure of coordination complexes using spectroscopic tools.	**K4**
4.	evaluate the spectral characteristics of complexes	**K5**
5.	design new catalysts from organometallic compounds	**K6**

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

Units	Contents	No. of Hours
I	**Chemistry of organometallic compounds:** Classification of organometallic compounds based on M-C bond - 18 and 16 electron rule; Bonding in metal - olefin complexes (example: Ziese's salt)- metal- acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes - Examples and MO approach to bonding in metallocenes; fluxional isomerism. Metal- carbonyl complexes: MO diagram of CO; Structure and bonding - bonding modes- MO approach of M-CO bonding- π-acceptor nature of carbonyl group- synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters - Structures based on polyhedral skeleton electron pair theory or Wade's rule.	**18**
II	**Reactions and catalysis of organometallic compounds:** Reactions of organometallic compounds: Oxidative addition - reductive elimination (α and β eliminations) - migratory insertion reaction and metathesis reaction. Organo-metallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst) - hydroformylation of olefins using cobalt or rhodium catalysts (oxo process) - oxidation of olefin (Wacker process) - olefin isomerisation - water gas shift reaction - cyclo-oligomerisation of acetylenes using Reppe's catalysts - Monsanto process.	**18**
III	**Inorganic spectroscopy-I:** IR spectroscopy: Effect of coordination on the stretching frequency- sulphato - carbonato - sulphito - aqua- nitro- thiocyanato - cyano - thiourea - DMSO complexes: IR spectroscopy of carbonyl compounds. NMR spectroscopy- Introduction - applications of ^{1}H- ^{15}N- ^{19}F- ^{31}P-NMR spectroscopy in structural identification of inorganic complexes - fluxional molecules - quadrupolar nuclei- effect in NMR spectroscopy	**18**
	Inorganic spectroscopy-II: Introductory terminologies: g and A parameters-	**18**

IV	definition - explanation and factors affecting g and A. Applications of ESR to coordination compounds with one and more than one unpaired electron - hyperfine and secondary hyperfine splitting and Kramer's doublets. ESR spectra of V(II)- Mn (II)- Fe (II)- Co (II)- Ni (II)- Cu (II) complexes- bis(salicylaldimine)copper (II) and $[(NH3)5Co\text{-}O2\text{-}Co\ (NH3)5]^{5+}$ Mossbauer spectroscopy - Mossbauer effect - Recoil energy - Mossbauer active nuclei - Doppler shift - Isomer shift - quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds.	
V	**Photo Electron Spectroscopy:** Theory – Types - origin of fine structures - shapes of vibrational fine structures - adiabatic and vertical transitions - PES of homonuclear diatomic molecules (N2- O2) and heteronuclear diatomic molecules (CO- HCl) and polyatomic molecules (H2O- CO2- CH4- NH3) - evaluation of vibrational constants of the above molecules. Koopman's theorem - applications and limitations. Optical Rotatory Dispersion - Principle of CD and ORD - Δ and λ isomers in complexes - Assignment of absolute configuration using CD and ORD techniques.	**18**
	Total	**90**

Self-study	Classification of organometallic compounds based on M-C bond - 18 and 16 electron rule

Textbooks:

1. Huheey. J. E, Keiter. E. A, Keiter. R. L and Medhi. O. K, 2006. *Inorganic Chemistry – Principles of structure and reactivity*, 4th Edition, Pearson Education Inc.
2. Meissler. G. L and Tarr. D.A, 2008. *Inorganic Chemistry*, 3rd Edition, Pearson Education Inc.
3. Gupta. B. D and Elias. A. K, 2013. *Basic Organometallic Chemistry: Concepts, Syntheses and Applications*, University Press.
4. Cotton. S. A and Wilkinson. G, 2019. *Introduction to Organometallic Chemistry*, Wiley.
5. Fox. M. A, 2018. *Inorganic Spectroscopy*, Oxford University Press.

Reference Books:

1. Manfred Bochmann, 2020. *Organometallics and Catalysis: An Introduction*, Oxford University Press.
2. Pilbrow. J.R, 2021. *Principles of Electron Paramagnetic Resonance*, Springer, Switzerland.
3. Dikanov. S. A and Salikhov. E. K. 2022. *Electron Spin Resonance: Analysis and Interpretation*, Wiley, United States.
4. Eric R. Milner and Vladimir I. Goldanskii, 2018. *ESR Spectroscopy: Applications in Chemistry and Biology*- Springer- Switzerland.
5. Brian M. Barwick, 2022. *Principles and Applications of Photoelectron Spectroscopy*, Academic Press, United States.

Web Resources:

1. https://chem.libretexts.org/Bookshelves/Inorganic Chemistry/Inorganic_ Chemistry_ (LibreTexts)/13%3A_Organometallic_Chemistry/13.%3A_Introduction_to_Organome tallicChemistry
2. https://www.usb.ac.ir/FileStaff/2896_2019-4-18-0-9-32.pdf
3. https://axial.acs.org/organometallic-chemistry/call-for-papers-experimental-studies-of- reaction-mechanisms-in-organometallic-chemistry-and-catalysis
4. https://www.ionicviper.org/web-resources-and-apps/inorganic-chemistry-spectroscopy- tutorial-theoretical-principles-and applications
5. https://www.pnnl.gov/explainer-articles/photoelectron-spectroscopy

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 IV

CORE COURSE VIII: PHYSICAL CHEMISTRY-II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234CC2	6	-	-	-	5	6	90	25	75	100

Prerequisite:

Students should have the basic knowledge of classical mechanics

Learning Objectives:

1. To understand the essential characteristics of wave functions and need for the quantum mechanics.
2. To know the importance of quantum mechanical models of particle in a box. rigid rotor and harmonic oscillator.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember the basic laws, equations and understand the characteristics of wave functions and symmetry functions.	**K1 & K2**
2.	apply the concept of quantum mechanics and group theory to predict the electronic structure.	**K3**
3.	classify the symmetry operation and wave equations.	**K4**
4.	evaluate eigen values and eigen functions	**K5**
5.	construct the character table for different point groups	**K6**

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

Units	Contents	No. of Hours
I	**Quantum mechanics:** Wave particle duality-Uncertainty principle- Particle wave - wave function. Properties of wave function. Normalized. Orthogonal. orthonormal. Eigen values. Eigen functions. Hermitian properties of operators. Introduction to quantum mechanics black body radiation. photoelectric effect. hydrogen spectrum. Need for quantum mechanics. Postulates of Quantum Mechanics. Schrodinger wave equation Time independent and time dependent	**18**
II	**Quantum models:** Particle in a box 1D- Two dimensional and three dimensional. degeneracy. application to linear conjugated molecular system. free particles. ring systems. Harmonic Oscillator wave equation and solution. anharmonicity. force constant and its significance. Rigid Rotorwave equation and solution. calculation of rotational constants and bond length of diatomic molecules.	**18**
III	**Applications to Hydrogen and Poly electron atoms:** Hydrogen atom and hydrogen like ions. Hamiltonian wave equation and solutions. radial and angular functions. representation of radial distribution functions. Approximation methods –variation methods: trial wave function. variation integral and application to particle in 1D box. Perturbation method first order applications. Hatrefock self-consistent field method. Hohenberg Kohn theorem and Kohn Sham equation. Helium atom electron spin. Pauli's exclusion principle and Slater determination.	**18**
IV	**Group theory:** Groups. sub groups. symmetry elements. operations. Classification axial and nonaxial. Dihedral point groups Cn. Cnh. Dn. Dnh. Dnd. Td and Oh. Matrix representation and classes of symmetry operations. reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula. Construction of character table for C2v. C2h. C3v and D2h point groups.	**18**

V	**Applications of quantum and group theory:** Hydrogen Molecule -Molecular orbital theory and Heitler London (VB) treatment. Energy level diagram. Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene. Cyclopropenyl- cyclo butadiene and Benzene. Applications of group theory to molecular vibrations. Electronic spectra of ethylene.	**18**
	Total	**90**

Self-study	Postulates of Quantum Mechanics. Schrodinger wave equation. Time independent and time dependent. Hydrogen Molecule- Molecular orbital theory and Heitler London (VB) treatment

Textbooks:

1. Prasad. R.K, 2010. *Quantum Chemistry*, 4th revised Edition, New Age International Publishers, New Delhi.
2. Cotton. F. A, 2003. *Chemical Applications of Group Theory*, 2nd Edition, John Wiley & Sons.
3. Vincent. A, 2013. *Molecular Symmetry and Group Theory -A Programmed Introduction to Chemical Applications*, 2nd Edition, John and Willy & Sons Ltd.
4. Engel. T and Philip Reid, 2018. *Quantum Chemistry and Spectroscopy*, 4th Edition, Pearson, New Delhi.
5. Vemulapalli. G. K, 2001. *Physical Chemistry*, Prentice Hall of India Pvt. Ltd.
6. McQuarrie. D. A, 2013. *Quantum Chemistry*, 2nd Edition, Viva Books Pvt. Ltd.

Reference Books:

1. Levine. N, 1983. *Quantum Chemistry*, 4th Edition, Allyn& Bacon Inc.
2. McQuarrie. D. A. and Simon. J. D, 2012. *Physical Chemistry. A Molecular Approach*, Viva Books Pvt. Ltd., New Delhi.
3. Rastogi. R. P and Srivastava. V. K, 1999. *An Introduction to Quantum Mechanics of Chemical Systems*, Oxford & IBH Publishing Co., New Delhi.
4. Flurry. R.L., Jr. 1980. *Symmetry Group Theory and Chemical applications*, Prentice Hall. Inc.
5. Hollas. J. M, 2011. *Symmetry in Molecules*, Chapman and Hall, London.

Web Resources:

1. https://nptel.ac.in/courses/104101124
2. https://ipc.iisc.ac.in/~kls/teaching.html
3. .https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/02.physical_chem istry.i /12.quantum_chemistry/et/5833_et_et.pdf
4. https://books.google.com/books/about/Applications_of_Group_Theory_in_Quantum.html?id=YCADw8U.BFY
5. https://link.springer.com/chapter/10.1007/3.540.05310.7_26

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	2	3	3	2
CO2	2	3	3	3	3	2	3	3	3	3	2	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2
CO4	3	3	3	2	3	3	3	3	3	2	3	3
CO5	2	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**13**	**15**	**13**	**14**	**15**	**13**	**15**	**14**	**14**	**14**	**14**	**13**
AVERAGE	**2.6**	**3**	**2.6**	**2.8**	**3**	**2.6**	**3**	**2.8**	**2.8**	**2.8**	**2.8**	**2.6**

3 – Strong- 2- Medium- 1- Low

SEMESTER IV

CORE LAB COURSE IV: ANALYTICAL INSTRUMENTATION TECHNIQUES PRACTICAL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234CP1	-	-	6	-	5	6	90	25	75	100

Pre-requisite

Basic principles of Instrumental methods of analysis

Learning Objectives

1. To analyze different constituents through instrumental methods of analysis.
2. To apply theoretical knowledge to develop the practical skills in analytical instrumentation.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall the basic concepts in analytical chemistry and understand the basic principles of instrumental methods of analysis.	**K1 & K2**
2.	apply the principles of instrumental methods of analysis.	**K3**
3.	analyze the constituents in a sample by selecting suitable analytical techniques.	**K4**
4.	evaluate the physical parameters using various analytical techniques.	**K5**
5.	design different experiments for the determination of physical parameters.	**K6**

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

S.No	Contents	No. of Hours
I	1. Conductometric titration of NH4Cl Vs NaOH. 2. Conductometric titration of CH3COONa Vs HCl. 3. Potentiometric titration of a mixture of HCl and CH3COOH Vs NaOH 4. Determination of pKa of weak acid by EMF method. 5. Potentiometric titration of FAS Vs K2Cr2O7 6. Potentiometric titration of KI Vs KMnO4. 7. Potentiometric titration of a mixture of Chloride and Iodide Vs AgNO3. 8. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel electrode.	**30**
II	1. Estimation of Fe, Cu and Ni by colorimetric method. 2. Estimation of Na and K by flame photometric method. 3. Estimation of the amount of nitrate present in the given solution using spectrophotometric method. 4. Analysis of water quality through COD, DO, BOD measurements. 5. Assay of Riboflavin and Iron in tablet formulations by spectrophotometry 6. Separation of (a) mixture of Azo dyes by TLC (b) mixture of metal ions by Paper chromatography 7. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry. 8. Estimation of Fe (II) by 1-10 phenanthroline using spectrophotometry	**30**
	Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments 1. UV-Visible	

III	2. IR 3. Raman 4. NMR 5. ESR 6. Mass etc.	**30**
	Total	**90**

Textbooks

1. Douglas A. Skoog, James Holler. F and Stanley Crouch, 2016. *Principles of Instrumental Analysis*, Cengage Learning.
2. Douglas A. Skoog, Donald M. West, James Holler. F and Stanley R. Crouch- 2013. *Fundamentals of Analytical Chemistry*, Cengage Learning.
3. Christian Gary, Derek P. Moore and Gary D. Christian, 2018. *Analytical Chemistry: Principles and Techniques*, Wiley.
4. Brain S. Furniss, Antony J. Hannaford, Peter W. G. Smith and Austin R. Tatchell, 1989. *Vogel's Text book of Practical Organic Chemistry*, 5th Edition, Longman Scientific & technical, John Wiley & Sons, Inc, New York.
5. Viswanathan. B and Raghavan. P. S, 2009. *Practical Physical Chemistry*, Viva Books, New Delhi.

Reference Books

1. Gurtu. J. N. and Kapoor. R, 2011. *Advanced Experimental Chemistry*, S. Chand and Co.
2. Yadav. J. B, 2001. *Advanced Practical Physical Chemistry*, Goel Publishing House.
3. Garland. G. W, Nibler. J. W, Shoemaker. D. P, 2009. *Experiments in Physical Chemistry*, 8th Edition, McGraw Hill.
4. Shikha Gulati, 2019. *Practical Inorganic Chemistry*, CBS Publishers and Distributors Pvt Ltd.
5. Miguel Valcárcel, Ángela I. López, Lorente, Rosario Pereiro, Gómez and Ian D. Wilson, 2017. *Fundamentals of Analytical Chemistry*, Wiley.

Web Resources

1. https://www.acs.org
2. https://www.euchems.eu/divisions/analytical-chemistry
3. https://www.rsc.org/Membership/Networking/InterestGroups/AnalyticalChemistryDivision/
4. https://www.nist.gov/analytical-chemistry

MAPPING WITH PROGRAMME OUTCOMES ANDPROGRAMME 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 IV

ELECTIVE COURSE VI: a): POLYMER CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC1	4	-	-	-	3	4	60	25	75	100

Prerequisite:

Students should have the basic knowledge of polymer chemistry.

Learning Objectives:

1. To learn the basic concepts and bonding in polymers.
2. To explain various types of polymerization reactions and kinetics.

Course Outcomes

On the successful completion of the course. students will be able to:		
1	learn the basic concepts of bonding and understand the importance of polymer chemistry	**K1 & K2**
2	apply the processing techniques in the manufacture of synthetic polymer	**K3**
3	analyze glass transition temperature- crystallinity and degradation in polymers.	**K4**
4	evaluate molecular weight and size of the polymer	**K5**
5.	synthesize new polymers for special applications.	**K6**

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

Units	Contents	No. of Hours
I	**Characterization. Molecular weight and its Determination:** Primary and secondary bond forces in polymers; cohesive energy. molecular structure. chemical tests. thermal methods. Tg. molecular distribution. stability. Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers.	**12**
II	**Mechanism and kinetics of Polymerization:** Chain growth polymerization: Cationic. anionic. free radical polymerization. Stereoregular polymers: Ziegler Natta polymerization. Reaction kinetics. Step growth polymerization. Degree of polymerization.	**12**
III	**Techniques of Polymerization and Polymer Degradation: b**ulk. solution. emulsion. suspension. solid. interfacial and gas phase polymerization. Types of polymer degradation. Thermal degradation. mechanical degradation, photodegradation and photo stabilizers.	**12**
IV	**Industrial Polymers:** Preparation of fibre forming polymers. elastomeric material. Thermoplastics: Polyethylene. Polypropylene. polystyrene. Polyacrylonitrile. Poly Vinyl Chloride. Poly tetrafluoro ethylene. nylon and polyester. Thermosetting Plastics: Phenol formaldehyde and expoxide resin. Elastomers: Natural rubber and synthetic rubber- Buna N. BunaS and neoprene. Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles. poly phenylene. poly pyrrole and poly acetylene. Polymethylmethacrylate. polyimides. polyamides. polyurethanes. polyureas. polyethylene and polypropylene glycols.	**12**
V	**Polymer Processing:** Compounding: Polymer Additives: Fillers. Plasticizers. antioxidants. thermal stabilizers. fire retardants and colourants. Processing Techniques: Calendaring. die casting. compression moulding. injection moulding. blow moulding and reinforcing. Film	**12**

	casting. Thermo foaming. Foaming.	
	Total	**60**

Self-study	Polymer Additives: Fillers. Plasticizers. antioxidants. thermal stabilizers. Fire retardants and colourants.

Textbooks

1. Billmeyer. F, 1971. *Textbook of Polymer Science*, 2nd Edition, New York: John Wiley and Sons.
2. Gowariker. V. R, 2009. *Polymer Science*, 2nd Edition, New Age International Pvt. Ltd., India.
3. Braun. D, 1982. *Simple Methods for Identification of Plastics*, Macmillan Publishing Co., New York.
4. Robert Weast. C, 1985. *Handbook of Chemistry and Physics*, 65th Edition, Boca Raton, FL, CRC Press.
5. Hightstown. N. J, 1990. *Modern Plastics*, Encyclopedia, Volume 67, McGraw Hill.

Reference Books

1. Odian. G, 2004. *Principles of Polymerization*, 4th Edition, John Wiley and Sons.
2. Manas Chanda, 2000. *Advanced Polymer Chemistry*,Marcel Dekker Inc.
3. Malcolm. P. Stevens, 1999. *Polymer Chemistry: An Introduction*, 3rd Edition, USA Oxford University Press.
4. Misra. G. S, 1993. *Introductory Polymer Chemistry*, John Wiley and Sons, New York.
5. Charles E. Carraher Jr, 2017. *Introduction to Polymer Chemistry*, 4th Edition, CRC Press.
6. Rodriguez. F, Cohen. C, Ober. C.K. and Archer. L, 2015. *Principles of Polymer Systems*, 6th Edition, CRC Press.

Web Resources:

1. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Physical_Methods_in_Chemistry_and_Nano_Science_(Barron)/02%3A_Physical_and_Thermal_Analysis/2.02%3A_Molecular_Weight_Determination
2. https://www.sciencedirect.com/topics/materials.science/polymerization.kinetics#:~:text=1%20Mechanism%20of%20Polymerization-initiator%20is%20fast%20and%20quantitative.
3. https://www.sciencedirect.com/topics/chemistry/polymer.degradation
4. https://www.britannica.com/science/industrial.polymer
5. https://www.sciencedirect.com/topics/materials.science/polymer.processing#:~:text=Polymer%20processing%20technologies%20are%20the-and%20so%20on%20%5B119%5D.

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 IV

ELECTIVE COURSE VI: b) BIOMOLECULES AND HETEROCYCLIC COMPOUNDS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic knowledge of organic molecules

Learning Objectives:

1. To learn the basic concepts and biological importance of biomolecules and natural products.
2. To explain various of functions of carbohydrates- proteins- nucleic acids- steroids and hormones.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recall the basic concepts of biomolecules and natural products.	**K1**
2.	understand the different methods of preparation of structurally different biomolecules and natural products.	**K2**
3.	apply the applications of biomolecules and their functions in the metabolism of living organisms.	**K3**
4.	analyze and rationalize the structure and synthesis of heterocyclic compounds.	**K4**
5.	evaluate the structure of biologically important heterocyclic compounds by different methods.	**K5**

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

Units	Contents	No. of Hours
I	**Chemistry and metabolism of carbohydrates:** Definition- classification and biological role of carbohydrates. Monosaccharides: Linear and ring structures (Haworth formula) of ribose- glucose- fructose and mannose (structure determination not required)- physical and chemical properties of glucose and fructose. Disaccharides: Ring structures (Haworth formula) – occurrence- physical and chemical properties of maltose- lactose and sucrose. Polysaccharides: Starch- glycogen and cellulose – structure and properties- glycolysis of carbohydrates.	12
II	**Steroids and Hormones:** Steroids-Introduction- occurrence- nomenclature- configuration of substituents. Diels' hydrocarbon- stereochemistry- classification- Diels' hydrocarbon- biological importance- colour reactions of sterols- cholesterol-occurrence- tests- physiological activity- biosynthesis of cholesterol from squalene. Hormones- Introduction- classification- functions of sex hormones- androgens and estrogens- adrenocortical hormones-cortisone and cortisol structure and functions of non-steroidal hormones- adrenaline and thyroxin.	12
III	**Proteins and nucleic acids:** Separation and purification of proteins – dialysis- gel filtration and electrophoresis. Catabolism of amino acids - transamination- oxidative deamination and decarboxylation. Biosynthesis of proteins: Role of nucleic acids. Amino acid metabolism and urea cycle. Structure- methods for the synthesis of nucleosides - direct combination- formation of heterocyclic base and nucleoside modification- conversion of nucleoside to nucleotides. Primary and secondary structure of RNA and DNA- Watson-Crick model- solid phase synthesis of oligonucleotides.	12

IV	**Lipids:** Introduction to oils and fats; common fatty acids present in oils and fats- Hydrogenntion of fats and oils- Saponification value- acid value- iodine number. Reversion and rancidity. Concept of Energy in Biosystems Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism and anabolism). Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein- fat and carbohydrate. Caloric value of food- standard caloric content of food types. Fatty acids - omega fatty acids - waxes - fats and oils - PUFA - phospholipids -- prostaglandins - biosynthesis of prostaglandins- thromboxanes- and prostacyclins.	**12**
V	**Fused Ring Heterocyclic Compounds:** Benzofused five membered rings: Indole- isoindole- benzofuran and benzothiophene- Preparation and properties. Benzofused six membered rings: Quinoline and isoquinoline: Preparation by ring closure reactions- Reactions: Mechanism of electrophilic and nucleophilic substitutions- oxidation and reduction reactions.	**12**
	Total	**60**

Self-study	Basic concepts of biomolecules

Textbooks:

1. Lindhorst. T. K, 2007. *Essentials of Carbohydrate Chemistry and Biochemistry*, Wiley VCH, North America.
2. Finar I. L, 1975. *Organic Chemistry*, Vol.2, 5th Edition, Pearson Education Asia.
3. Ahluwalia V. K. and Goyal. M, 2000. *Textbook of Heterocyclic compounds*, Narosa Publishing, New Delhi.
4. Jain M. K. and Sharma S. C, 2014. *Modern Organic Chemistry*, Vishal Publishing Co., Jalandhar, Delhi.
5. Ahluwalia. V. K., 2009. *Steroids and Hormones*, Ane books pub., New Delhi.

Reference Books:

1. Finar. I. L., 2004. *Organic Chemistry*, Vol.1, 6th Edition, Pearson Education Asia.
2. Pelletier, 2000. *Chemistry of Alkaloids*, Van Nostrand Reinhold Co.
3. Shoppe, 1994. *Chemistry of the steroids*, Butter worthes.
4. Khan. I. A. and Khanum. A, 2004. *Role of Biotechnology in medicinal & aromatic plants*, Vol 1 & 10, Ukkaz Publications, Hyderabad.
5. Singh. M. P. and Panda. H., 2005. *Medicinal Herbs with their formulations*, Daya Publishing House, Delhi.

Web Resources:

1. https://bit.ly/39LXStz
2. https://www.organic-chemistry.org/
3. https://www.studyorgo.com/summary.php
4. https://www.clutchprep.com/organic-chemistry

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

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

3 – Strong- 2- Medium- 1- Low

SEMESTER IV

ELECTIVE COURSE VI: c) CHEMISTRY OF NATURAL PRODUCTS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic knowledge of natural products

Learning Objectives:

1. To learn the basic concepts and biological importance of biomolecules and natural products.
2. To explain various of functions of carbohydrates- proteins- nucleic acids- steroids and hormones.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember the biological importance of chemistry of natural products	K1
2.	understand the process of isolation and characterization of synthesized natural products	K2
3.	interpret the experimental data scientifically to improve biological activity of active components	K3
4.	analyze the structure of phytochemical constituents by chemical and physical methods	K4
5.	elucidate the structure of alkaloids- terpenoids- carotenoids- falvanoids and anthocyanins	K5

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

Units	Contents	No. of Hours
I	**Alkaloids:** Introduction- occurrence- classification- isolation and functions of alkaloids. Classification- general methods of structural elucidation. Chemical methods of structure determination of Coniine- Piperine- Nicotine- Papaverine. Atropine- Quinine- Belladine- Cocaine- Heptaphylline- Papaverine and Morphine.	12
II	**Terpenoids:** Introduction- occurrence- Isoprene rule- classification. General methods of determining structure. Structure determination of Camphor- Abietic acid- Cadinene- Squalene- Zingiberine. **Carotenoids:** Introduction- geometrical isomerism- Structure- functions and synthesis of β-carotene and vitamin-A.	12
III	**Anthocyanins and flavones**: Anthocyanins: Introduction to anthocyanins. Structure and general methods of synthesis of anthocyanins. Cyanidine chloride: structure and determination. Flavones: Biological importance of flavones. Structure and determination of flavone and flavonoids. Quercetin: Structure determination and importance.	12
IV	**Purines and Steroids:** Purines: Introduction- occurrence and isolation of purines. Classification and spectral properties of steroids. biological importance- Structure and synthesis of Uric acid and Caffeine. Steroids: Steroids-Introduction- occurrence- nomenclature- configuration of substituents- Diel's hydrocarbon- stereochemistry- classification- Diels' hydrocarbon- biological importance- colour reactions of sterols- cholesterol-occurrence- tests- physiological activity- biosynthesis of cholesterol from	12

	squalene.	
V	**Natural Dye**s: Occurrence- Sources of natural dyes: plants, animals, minerals-classification- classification based on origin-chemical structure- and application-isolation- purification- properties- colour and constitution- Relationship between molecular structure and color- Structural determination- spectroscopy- chromatography for structural analysis and synthesis of indigoitin and alizarin.	**12**
	Total	**60**

Self-study	Introduction- occurrence- classification- isolation and functions of alkaloids

Textbooks

1. Chatwal. G. K, 2009. *Organic Chemistry on Natural Products*, Vol. 1, Himalaya Publishing House, Mumbai.
2. Chatwal. G. K, 2009. *Organic Chemistry on Natural Products,* Vol. 2, Himalaya Publishing House, Mumbai.
3. Agarwal. O. P, 1997. *Chemistry of Organic Natural Products,* Vol. 1, Goel Publishing House, Meerut.
4. Agarwal. O. P, 1997. *Chemistry of Organic Natural Products*, Vol. 2, Goel Publishing House, Meerut.

Reference Books

1. Finar. I. L, 2004. *Organic Chemistry* Vol.1, 6th Edition, Pearson Education Asia.
2. Pelletier, 2000. *Chemistry of Alkaloids*, Van Nostrand Reinhold Co.
3. Shoppe, 1994. *Chemistry of the steroids*, Butter worthes.
4. Khan and A. Khanum, 2004. *Role of Biotechnology in medicinal & aromatic plants*, Vol 1 and Vol 10, Ukkaz Publications, Hyderabad.
5. Finar. L, 1975. Organic Chemistry, Vol. 2, 5th Edition, Pearson Education Asia.

Web Resources

1. https://sites.google.com/site/chemistryebookscollection02/home/organic-chemistry/organic
2. https://www.sciencedirect.com/topics/neuroscience/terpenoid
3. https://www.sciencedirect.com/science/article/pii/S0963996921008292
4. https://www.sciencedirect.com/science/article/abs/pii/0003986162903259
5. https://textilelearner.net/natural-dyes-properties-types-production/

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	3	3	3	3	3	2	3	3	3	2
CO4	2	2	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**	**14**	**15**	**15**	**14**	**12**	**15**	**13**	**15**	**14**	**15**	**13**
AVERAGE	**2.4**	**2.8**	**3.0**	**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 IV

ELECTIVE COURSE VII: a) RENEWABLE ENERGY SOURCES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC4	3	1	-	-	3	4	60	25	75	100

Pre-requisite:

Students should have knowledge on basic concepts such as force- energy- work power- electricity and how renewable energy systems operate as well as the principles of sustainability.

Learning Objectives:

1. To understand energy scenario- energy sources and their utilization.
2. To explore society's present needs and future energy demands.

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	remember and understand the importance of various sources of non-conventional energy.	**K1 & K2**
2.	apply the principles of renewable energy and sustainability in energy conservation.	**K3**
3.	analyze the advantages and disadvantages of different non-conventional energy sources	**K4**
4.	evaluate solar energy radiation- wind energy data and conversion efficiency of fuel cells	**K5**
5.	design fuel cells for sustainable energy development	**K6**

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

Units	Contents	No. of Hours
I	**Introduction to Energy Sources:** Introduction - conventional energy sources - coal - oil - gas - agricultural and organic wastes - water power - thermal power and nuclear power. Principles of renewable energy- energy and sustainable development - fundamentals and social implications - worldwide renewable energy availability- renewable energy availability in India- shale. Non-conventional energy sources - solar energy - wind energy- energy from bio-mass and bio-gas - ocean thermal energy - tidal energy -geothermal energy and hydrogen energy. Advantages of renewable energy. Introduction to Internet of energy (IOE).	**12**
II	**Solar Energy:** Fundamentals - Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces -Solar radiation Measurements- Pyrheliometers-Pyrometer- Sunshine Recorder. Solar Thermal systems: Flat plate collector- Solar distillation; Solar Pond electric power plant. Solar electric power generation- Principle of Solar cell - Photovoltaic system for electric power generation - advantages- Disadvantages and applications of solar photovoltaic system.	**12**
III	**Wind Energy**: Properties of wind- availability of wind energy in India - wind velocity and power from wind - major problems associated with wind power.Basic components of wind energy conversion system (WECS) - Classification of WECS- Horizontal axis- single- double and multiblade system. Vertical axis- Savonius and darrieus types.	**12**
IV	**Biomass Energy- Tidal Power and Ocean Thermal Energy Conversion:** Introduction; Photosynthesis Process; Biofuels- Biomass Resources; -Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass	**12**

	gasification. Tides and waves as energy suppliers and their mechanics - fundamental characteristics of tidal power -harnessing tidal energy - advantages and limitations. Ocean Thermal Energy Conversion: Principle of working- OTEC power stations in the world- problems associated with OTEC.	
V	**Green Energy**: Introduction- Fuel cells: Classification of fuel cells H2; Operating principles - Zero energy Concepts - Benefits of hydrogen energy- hydrogen production technologies (electrolysis method only) - hydrogen energy storage - applications of hydrogen energy - problem associated with hydrogen energy.	**12**
	Total	**60**

Self-study	Introduction to conventional energy sources

Textbooks:

1. Rai. G.D., 2004. *Non-conventional Energy Sources*, Khanna Publications, India.
2. Wengenmayr, R., Bührke, T. & Brewer, W.D., 2012. *Renewable Energy: Sustainable Energy Concepts for the Energy Change*, 2nd Edition, Wiley VCH, New York.
3. Nelson. V., 2011. *Introduction to Renewable Energy (Energy and the Environment)*, CRC Press, New York.
4. Twidell, J. & Weir. T, 2006. *Renewable Energy Resources*, 2nd Edition, Taylor and Francis, New York.

Reference Books:

1. Shobh Nath Singh, 2018. *Non-Convention Energy Resources*, Pearson.
2. Chiras. D, 2006. *Achieving Energy Independence through Solar, Wind, Biomass and Hydropower*, Mother Earth News Wiser Living.
3. Tester. J.W, Drake. E. M, Driscoll. M. J, Golay. M.W and Peters. W.A, 2006. *Sustainable Energy*, 2nd Edition, Prentice-Hall of India, New Delhi.
4. Twidell. J and Weir. T, 2015. *Renewable Energy: Power for a Sustainable Future,* Oxford University Press, Oxford, United Kingdom.
5. Kreith F and Kreider. J. F, 2013. *Principles of Renewable Energy Systems,* CRC Press, Boca Raton, Florida, USA.

Web Resources:

1. E-book URL:https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
2. E-book URL:https://www.pdfdrive.com/non-conventional-energy-systems-nptel- d17376903.html
3. E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applications- e33423592.html
4. E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources- e34339149.html
5. https://onlinecourses.nptel.ac.in/noc18_ge09/preview

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 IV

ELECTIVE COURSE VII: b) SUPRAMOLECULAR CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC5	4	-	-	-	3	4	60	25	75	100

Pre-requisite

Basic knowledge of supramolecular chemistry

Learning Objectives

1. To understand the fundamental concepts and language of supramolecular chemistry-
2. To analyze the principles and synthesis strategies of Metallo Organic Frameworks (MOFs).

Course Outcomes

On the successful completion of the course- students will be able to:		
1.	recognize the aromaticity of molecules and understand the foundational concepts and terminology of supramolecular chemistry.	**K1 & K2**
2.	apply MOFs in drug design and their applications in NLO materials and OLEDs.	**K3**
3.	analyze molecular and supramolecular electronic devices- including molecular wires and switchable molecular wires.	**K4**
4.	evaluate the role of supramolecular chemistry in the development of nanoscience and technology- particularly in sensor technologies.	**K5**
5.	synthesize macromolecules for special application.	**K6**

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

Units	Contents	No. of Hours
I	**Concepts of Supramolecular Chemistry** Concepts and languages of supramolecular chemistry – various types of noncovalent interactions – hydrogen bonds- C-H…X interactions- halogen bonds – π-π interactions- non–bonded interactions – various types of molecular recognition. Crystal engineering of organic solids – hydrogen bonded supramolecular patterns involving water / carboxyl / halide motifs - concepts of different types of synthons based on non-covalent interactions- principles of crystal engineering and non-covalent synthesis – polymorphism and pseudopolymorphism – supramolecular isomorphism/ polymorphism – crystal engineering of pharmaceutical phases.	**12**
II	**Metallo Organic Frameworks:** M.O.F (Metallo Organic Frameworks) – organometallic systems – combinations of different interactions to design molecular rods- triangles- ladders- networks- etc. – design of nanoporous solids – interligand hydrogen bonds in metal complexes – implications for drug design – crystal engineering of NLO materials- OLED.	**12**
III	**Co-receptor Molecules and Multiple Recognition**: Dinuclear and polynuclear metal ion cryptates – linear recognition of molecular length by ditopic co-receptors – heterotopic co-receptors – cyclophane receptors- amphiphilic receptors and large molecular cages –multiple recognition in metallo receptorssupramolecular dynamics.	**12**
IV	**Supramolecular Reactivity and Catalysis:** Catalysis by reactive macrocyclic cation receptor molecules – catalysis by reactive anion receptor molecules –catalysis with cyclophane type receptors - supramolecular metallocatalysis – cocatalysis – catalysis of synthetic reactions – biomolecular and abiotic catalysis. Supramolecular chemistry in solution –cyclodextrin-micelles-dendrimers- gelators classification and typical reactions– applications.	**12**

V	**Supramolecular Devices:** Supramolecular devices and sensors – various types of supramolecular devices–an overview–supramolecular photochemistry – molecular and supramolecular photonic devices light conversion and energy transfer devices – molecular and supramolecular electronic devices – electronic conducting devices – molecular wires-modified and switchable molecular wires– molecular and supramolecular ionic devices – tubular mesophases- molecular protonics – switching devices – electro-photo switch – ion and molecule sensors – role of supramolecular chemistry in the development of nanoscience and technology.	**12**
	Total	**60**

Self-study	Concepts and languages of supramolecular chemistry

Textbooks

1. Schneider. H. J, Yatsimirsky. A., 2000. *Principles and Methods in Supramolecular Chemistry*, Wiley.
2. Desiraju, G. R., Vittal J. J. and Ramanan, A., 2011. *Crystal Engineering: A textbook*, World Scientific Publishing Co. Pvt. Ltd.

Reference Books

1. Steed. J. W, Atwood. J. L., 2009. *Supramolecular Chemistry*, 2nd Edition, John Wiley & Sons Inc.
2. Lehn. J. M., 1995. *Supramolecular Chemistry*, 1st Edition, Wiley VCH.
3. Dietrich. B, Viout. P, Lehn. J. M, 1993. *Macrocylic Chemistry*, VCH.
4. Desiraju. G, Steiner. T, 2001. *The Weak Hydrogen Bond*, Oxford science publications.
5. Kasi. P. S. and Kalsi. J. P, 2017. *Bioinorganic and Supramolecular Chemistry*, 3rd Edition, New Age Publications.

Web Resources

1. https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall- 2008/pages/syllabus/
2. https://pubs.acs.org/doi/10.1021/cr300014x
3. https://onlinelibrary.wiley.com/doi/10.1002/3527607439.ch4
4. https://biointerfaceresearch.com/wpcontent/uploads/2021/11/20695837125.68156832.pdf
5. https://biointerfaceresearch.com/wpcontent/uploads/2021/11/20695837125.68156832.pdf

MAPPING WITH PROGRAMME OUTCOMESAND 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 IV

ELECTIVE COURSE VII: c) ENVIRONMENTAL CHEMISTRY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234EC6	4	-	-	-	3	4	60	25	75	100

Prerequisite:

Students should have the basic knowledge of components of environment and the interaction of humans with environment.

Learning Objectives:

1. To learn the basic concepts of environmental science and ecology.
2. To identify the sources of pollution.

Course Outcomes

On the successful completion of the course. students will be able to:		
1	recall the knowledge about environment and understand the phosphate- carbon- hydrogen- nitrogen and hydrological cycles in ecosystem.	**K1 & K**
2	apply the knowledge gained to propose solutions and strategies for improving air- water and soil quality.	**K3**
3	identify the causes and consequences of air pollution- water pollution and soil pollution	**K4**
4	evaluate the water quality parameters	**K5**
5	create eco-friendly recycling process.	**K6**

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

Units	Contents	No. of Hours
I	**Introduction and Classification** Introduction – Environmental science – Environmental chemistry – Ecology – Definition – Ecosystem – Cycling of mineral elements and gases – Phosphate cycle – Carbon cycle – Hydrogen cycle – Nitrogen cycle – Hydrological cycle – Environmental segments – Pollution and its types: air pollution – water pollution – soil pollution – radioactive pollution – thermal pollution noise pollution – marine pollution – other types of pollution – and its effects and control – remedial measures	12
II	**Air Pollution** Introduction – Sources of air pollution – air pollutants – classification and effects of air pollutions – oxides of nitrogen. sulphur and carbon – acid rain – effects and control – hydrogen sulphide – effects and control – carbon mono oxide – effects and control –photochemical smog – effects and control fly ash – effects and control – green house effect – global warming – effects and control – ozone layer – ozone depletion – cholorofluoro carbons – effects and control.	12
III	**Water Pollution** Introduction – types of water – water pollution – sources of water pollution – water pollutants – classification – physical. chemical and biological – inorganic pollutants and toxic metals – organic pollutants – radioactive pollutants in water pesticides and fertilizers – suspended particles – water quality – water quality index – ill effects of water pollutants – fluorosis – water pollution control – water treatment – primary. secondary and tertiary treatment – desalination – reverse osmosis – sewage and industrial waste water treatment.	12
IV	**Soil Pollution** Introduction – types of soil – soil pollution – types – indicators of soil pollution – plants as indicators of pollution – sources of soil pollution – fertilizers and pesticides – radioactive pollutants – solid wastes – soil sediments as pollutant – soil erosion – treatment of soil pollutants – treatment of solid wastes thermal methods – land filling compositing – land protection – remedial measures for soil pollution.	12

V	**Analysis of Pollutants** Introduction – analysis of air pollutants – units – sampling – devices and methods for sampling – measurement: UV– Visible spectrometry – IR spectrometry – emission 2815 spectrometry – turbidimetry nephelometry – gas chromatography – HPLC – chemiluminescence of nitrogen oxides – IR photometry – conductometry – analysis of water pollutants – units – sampling – devices and methods for sampling – measurement: UV-Visible spectrometry – titration – analysis of different water quality parameters – BODCOD – analysis and monitoring of pesticides and industrial pollutants.	**12**
	Total	**60**

Self-study	Introduction – Environmental science – Environmental chemistry – Ecology –Definition – Ecosystem

Textbooks:

1. Sharma. B.K. and Kaur. H., 1997. *Environmental Chemistry*, Krishna Prakashan, Meerut.
2. De. A. K, 1994. *Environmental Chemistry,* Wiley Eastern Ltd., Meerut.
3. Deswal. S. and Deswal. A., 2005. *A Basic Course in Environmental Studies*, Dhanpat Rai & Co ltd., Delhi.
4. Sharma. P.D., 1994. *Ecology and Environment,* Ashish Publications.
5. Wagner. K.D, 1998. *Environment Management*, W.B. Saunders Co, Philidelphia, USA.

Reference Books:

1. Billmeyer. F. N, 1971. *Textbook of Polymer Science*. Wiley Interscience.
2. Kumar. A and Gupta. S. K., 1978. *Fundamentals and Polymer Science and Engineering*, Tata McGraw Hill.
3. Mukherjee. A.K, 1986. *Environmental Pollution and Health Hazards, Causes and Control,* Galgotia Press, New Delhi.
4. Manivasakam. N, 1985. *Physicochemical Examination of Water, Sewage and Industrial Effluents*, Pragati Prakashan Publication, Meerut.

   5.Singh. N and Sontakke. N.A., 2002. *On Climatic fluctuations and Environment changes on Indo-Gangetic Plains*, India

Web Resources:

1. https://en.wikipedia.org/wiki/Pollution
2. https://www.britannica.com/science/air-pollution
3. https://en.wikipedia.org/wiki/Water_pollution
4. https://en.wikipedia.org/wiki/Soil_contamination
5. https://www.sciencedirect.com/book/9780128169346/modern-environmental-analysis- techniques-for-pollutants

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	2	3	3	3	2
CO2	2	3	3	3	3	2	3	3	2	3	3	3
CO3	3	3	2	3	3	3	3	3	3	3	2	3
CO4	2	3	3	3	3	2	3	2	3	3	3	3
CO5	3	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**13**	**15**	**13**	**15**	**14**	**13**	**15**	**13**	**14**	**15**	**14**	**14**
AVERAGE	**2.6**	**3**	**2.6**	**3**	**2.8**	**2.6**	**3**	**2.6**	**2.8**	**3**	**2.8**	**2.8**

3 – Strong. 2- Medium. 1- Low

SEMESTER IV

SKILL ENHANCEMENT COURSE III: BUSINESS SKILLS FOR CHEMISTS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234SE1	3	1	-	-	2	4	60	25	75	100

Pre-requisites:

Students should know the basic skills in Chemistry.

Learning Objectives:

1. To understand the business fundamentals including finance, marketing, operations, and management.
2. To develop communication skills among the students.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand financial statements, including balance sheets, income statements, and cash flow statements.	**K1&K2**
2	apply financial principles to analyze the economic viability of chemical projects and make informed business decisions.	**K3**
3	identify market opportunities and develop strategies for product commercialization and market penetration.	**K4**
4	assess market demand for chemical products and technologies.	**K5**
5	cultivate a professional network within the chemical industry and negotiate effectively to achieve business objectives and foster collaboration.	**K6**

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

Units	Contents	No. of Hours
I	**Introduction to Business Skills for Chemists:** Overview of Business Skills Integration-Importance of Business Skills in Chemistry-Integration of Business and Scientific Expertise-Understanding Career Pathways-Industry vs. Academia: Career Prospects- Identifying Transferable Skills-Basic Principles of Business Communication-Clarity and Precision in Communication-Tailoring Messages to Different Audiences-Professional Etiquette and Networking-Professionalism in Various Settings-Effective Networking Strategies.	**12**
II	**Communication Skills for Chemists:** Effective Written Communication-Crafting Clear and Concise Emails-Writing Professional Reports and Proposals-Oral Communication and Presentation Skills-Structuring Engaging Presentations-Effective Speaking and Delivery Techniques-Interpersonal Communication and Conflict Resolution-Active Listening and Empathy- Strategies for Resolving Conflicts Professionally.	**12**
III	**Project Management for Chemists:** Project Management Fundamentals-Defining Project Scope and Objectives-Establishing Realistic Timelines and Milestones-Planning and Scheduling Techniques-Work Breakdown Structure (WBS)-Gantt Charts and Critical Path Analysis-Resource Allocation and Budgeting-Identifying Project Resources- Budget Development and Cost Control-Risk Management Strategies-Identifying and Assessing Project Risks-Mitigation and Contingency Planning.	**12**
IV	**Intellectual Property and Patents:** Intellectual Property Rights Overview-Patents, Trademarks, and Copyrights-Importance of Intellectual Property in Chemistry-Patenting Process and Strategies-Patent Search Techniques-Drafting and Filing Patent Applications-	**12**

	Protection of Intellectual Property-Confidentiality Agreements and NDAs-Licensing and Technology Transfer-Patent Searching Techniques-Online Databases and Search Strategies-Analyzing Patent Documents.	
V	**Entrepreneurship and Commercialization:** Introduction to Entrepreneurship-Characteristics of Successful Entrepreneurs-Identifying Market Opportunities-Market Evaluation and Feasibility-Market Research Methods-Assessing Market Potential and Competition-Business Models and Funding Options-Types of Business Models in Chemistry- Sources of Funding for Startups-Commercialization Strategies-Product Development and Launch-Marketing and Distribution Channels.	**12**
	Total	**60**

Self-study	Functions and principles of business skills

Textbooks

1. Coghill, Anne M., and Lorrin R. Garson., 2006. *The ACS Style Guide: Effective Communication of Scientific Information.*, American Chemical Society (ACS) Publications.
2. Shadle, L. A., 1996. *Project Management for Scientists and Engineers*, Wiley-Interscience.
3. Javier Garcia-Martinez, Kunhao Li, 2021. "*Chemistry Entrepreneurship*", Wiley Online Library.
4. David Pressman, 2021. "*Patent It Yourself*", NOLO.
5. Alex Cowan, 2012. "*Starting a Tech Business: A Practical Guide for Anyone Creating or Designing Applications or Software*", John Wiley & Sons.

Reference Books

1. Gordon, A. J., Ford R. A. and Goodyear. P. G., 2018. "*The Chemist's Companion: A Handbook of Practical Data, Techniques and References*, Wiley.
2. Michael and Virginia Speegle, 2019. "*Business Essentials for Scientists and Engineers*", CRC Press.
3. Jeffrey L. Magee, 2017. "*Chemical Entrepreneurship: The Central Role of the Academic Entrepreneur*", Springer.
4. Lory Mitchell Wingate, 2020. "*Project Management for Research and Development: Guiding Innovation for Positive R&D Outcomes*", Routledge.
5. Peter Thielst, 2016. "*Patenting for Scientists and Engineers*", Elsevier.

Web Resources

1. https://www.acs.org/content/acs/en/careers/entrepreneurs.html
2. https://communities.acs.org/groups/entrepreneurship-and-innovation
3. https://www.chemistryworld.com/business-industry
4. https://www.sba.gov/business-guide
5. https://ocw.mit.edu/courses/entrepreneurship

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	3	2	3	3	3	3	3	3
CO2	3	3	3	2	2	3	3	3	2	3	3	2
CO3	3	3	2	3	3	3	3	2	3	3	2	3
CO4	2	3	2	3	2	2	2	3	2	3	3	3
CO5	3	3	3	3	3	3	3	2	3	3	2	3
TOTAL	**14**	**15**	**13**	**14**	**13**	**13**	**14**	**13**	**13**	**15**	**13**	**14**
AVERAGE	**2.6**	**3.0**	**2.6**	**2.8**	**2.6**	**2.6**	**2.8**	**2.6**	**2.6**	**3.0**	**2.6**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

SELF LEARNING COURSE: CHEMISTRY FOR COMPETITIVE EXAMINATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
CP234SL1	-	-	-	-	1	-	-	25	75	100

Pre-requisite:

Basic knowledge of general chemistry.

Learning Objectives

1. To gain insights into the fundamental concepts in chemistry.
2. To learn various methods to solve problems involving titrations and pH calculations.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand the basic chemistry principles and solve related problems effectively.	**K1**
2.	understand the chemical concepts through observation and simple experiments.	**K2**
3.	recognize different types of pollution and their impact on the environment.	**K3**
4.	apply chemistry knowledge to understand and improve materials.	**K4**
5.	gain hands-on abilities in chemical processes for real-world applications.	**K5 &K6**

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

Units	Contents
I	**Basic Chemistry- I:** Elements – atoms and molecules – Metals and nonmetal – metaolloid, alloy, ore and minerals - Chemical formulae and symbols – Important basic terms such as pressure, volume, atomic mass, molecular mass, temperature, atomic number – Types of chemical reactions (exothermic and endothermic, Physical and chemical changes, oxidation and reduction) – ideal and real gas - Important laws of chemistry (Boyle's law, Charle's law, Hess's law, Grahams law of diffusion, Beer's law, Henry's law, Faraday's law, Law of conservation of matter or energy).
II	**Basic Chemistry- II: (Only elementary idea can be given)** Different concepts of Acids and Bases (Arrhenius, Bronsted and Lewis) – pH concept (no calculation) – Water – Hard and soft water - Chemical nature of metals- Steel and iron (no manufacture) – heat treatment of steel – Solutions and their types (True, Colloidal and suspension) – uses of colloidal solution – Buffer solution – Nuclear Chemistry – isotopes and radioactivity Definitions of some important chemical processes (Haber's, Contact's, Ostwald's, Process)
III	**Environmental Chemistry:** Pollution and types of pollutions – Composition of atmosphere – Major regions of atmosphere and their characteristics – Elementary idea of Green house effects and Acid rain – Air pollution – Control of air pollution and their harmful effects – CFC, Global warming, substitute for CFC (Just name only)-Water pollution – Dissolved oxygen – BOD, COD and TDS (elementary idea only)
IV	**Chemistry in service of man –I: (Only elementary idea can be given)** Plastics – Classification with examples – Polymer (natural and synthetic) – Soaps and Glass – Annealing of glass – Cement – Constituents and setting and hardening of

	cement – Rubber – Types with examples and vulcanization of rubber- Corrosion of metal – prevention – Lubricants (definition and classification) – Fuel – Classification with suitable examples - calorific value – LPG and Rocket fuel.
V	**Chemistry in service of man –II: (Only elementary idea can be given)** Food adulterants – common food adulterants and their harmful effects and tests to identify them– Classification and biological functions of Vitamins A, B6, B12, C, D, E and K (structural elucidation not required) – Classification and biological functions of antibiotics – penicillin, chloroamphenicol, streptomycin and tetracycline.

Textbooks

1. Tyagi, O.D., Mehra, M. ,1990. *A Text book of Environmental Chemistry,* Anmol Publication.
2. Bagawathi Sundari, K. ,2006. *Applied Chemistry*, MJP Publishers, Chennai.
3. Tara Chand, 2008. *General Studies Manual*, TMH Publishers.

Reference Books

1. Theodore L. Brown, Eugene LeMay. H and Bruce E., 2021. *Chemistry: The Central Science:* Pearson.
2. Stanley E. Manahan, 2019. *Environmental Chemistry*, CRC Press.
3. American Chemical Society, 2019. *Chemistry in Context*, McGraw-Hill Education.
4. Robert J. Young, Peter A. Lovell, 2019. *Introduction to Polymers*, CRC Press.
5. Owen R. Fennema, 2019. *Food Chemistry*, CRC Press.

Web Resources

1. https://openoregon.pressbooks.pub/biochemistry/chapter/1-2-introduction-basic-chemistry-biology-libretexts/
2. https://ncert.nic.in/pdf/syllabus/desm_s_Chemistry.pdf
3. https://ncert.nic.in/textbook/pdf/kech207.pdf
4. https://www.forgottenbooks.com/de/download/ChemistryintheServiceofMan_10007755.pdf
5. https://elibrary.tucl.edu.np/bitstream/123456789/1485/3/12650.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	2	3	3	2
CO2	2	3	3	3	3	2	3	3	3	3	2	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2
CO4	3	3	3	2	3	3	3	3	3	2	3	3
CO5	2	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**13**	**15**	**13**	**14**	**15**	**13**	**15**	**14**	**14**	**14**	**14**	**13**
AVERAGE	**2.6**	**3**	**2.6**	**2.8**	**3**	**2.6**	**3**	**2.8**	**2.8**	**2.8**	**2.8**	**2.6**

3 – Strong- 2- Medium- 1- Low

SEMESTER III & IV

LIFE SKILL TRAINING II: VALUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST2	1	-	-	-	1	1	15	50	50	100

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

Learning Objectives

1. To guide students in making wise choices and decisions, and to help them discover the true purpose of their lives.
2. To ensure students not only grasp the concept of values but also incorporate them into their actions and attitudes.

Course Outcomes

On completion of this course the student will be able to		
1	recognize the perception of life and lead a positive life	**K1**
2	understand relationship with family, friends and the society	**K2**
3	develop as socially responsible citizens.	**K3**
4	assess goals, fix targets and value life	**K4**
5	create a peaceful, communal community and embrace unity.	**K6**

K1-Remember; **K2**-Understand; **K3**-Apply; **K4 – Analyse; K6**- Create

Units	Contents	No. of Hours
I	**Positive Thinking -** Why you should change your thinking? – How to became a better thinker- Putting yourself in the right place to think- Portrait of the good thinker. **Habits-** Habits vs. Addiction- Why are life styles changes so difficult to hold on to? - Habit Swapping.	3
II	**Art of Listening-** Many faces of speech- To be truly present- Valuing the other- Activating the subconscious. **Leadership-** Introduction- Who is a better leader? - Qualities of a Leader- You too can be a leader.	3
III	**Interpersonal Relationship**- Introduction - Factors that build trust- Steps to build a positive personality. **Managing Emotions**- 7 'Root' emotions- Importance of managing emotions- Why is it important to manage emotions?	3
IV	**Stress Management –** Highly effective tips for relieving stress- Fast-Acting Self Relief Strategies. **Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
V	**Forgiveness-** What is forgiveness- Value of forgiveness- Benefits of forgiving- Self-forgiveness. **Gratitude –** What is gratitude? – How gratitude arises? –Features of gratitude – Gratitude is recognizing and acknowledging.	3
TOTAL		**15**
Self-Study Salient values for life, Human Rights, Social Evils and how to tackle them,		

Holistic living, Duties and responsibilities.

Textbooks

Life Skill Training – II, 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. Romuald Andrade. (2015). *Habit Triggers: How To Create Better Routines And Success Rituals To Make Lasting Changes In Your Life*. Kindle Edition.
4. William Fergus Martin. (2014). *Four Steps to Forgiveness:* A *Powerful Way To Freedom, Happiness And Success*. Findhorn Press.
5. Robert A. Emmons and Joanna Hill (2001). *Words Of Gratitude for Mind, Body, and Soul*. USA: Templeton Foundation Press.

Web Resources

1. https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/positive-thinking/art-20043950
2. https://jamesclear.com/habits
3. https://www.skillsyouneed.com/ps/managing-emotions.html
4. https://emeritus.org/in/learn/what-is-leadership/
5. https://www.verywellmind.com/how-to-maintain-interpersonal-relationships-5204856