

ETHIRAJ COLLEGE FOR WOMEN

(AUTONOMOUS)

CHENNAI - 600 008

DEPARTMENT OF CHEMISTRY

Syllabus for

M.Sc CHEMISTRY



CHOICE BASED CREDIT SYSTEM

OUTCOME BASED EDUCATION

(Syllabus effective from the Academic year 2021 -2022)

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**ETHIRAJ COLLEGE FOR WOMEN (AUTONOMOUS)
CHENNAI -600 008**

**DEPARTMENT OF CHEMISTRY
MASTER OF SCIENCE IN CHEMISTRY
CBC System
(Syllabus effective from the academic year 2021 - 2022)**

Department of Chemistry is revising the syllabus under CBC system with effect from the academic year 2021-2022, as specified by the Government of Tamil Nadu. Electives - (Major) components will enrich the knowledge of the students in the currently developing fields of Chemistry and Electives - (Non-major) will enable the students to be entrepreneurs. In the syllabus there are four Soft skill courses one each in every Semester.

The duration of the course is two academic years. Every academic year is divided into two semesters. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is related to the number of lecture, tutorial and practical hours (LTP) for a particular subject. It is also related to the number of hours a student spends learning a subject or carrying out an activity

REGULATIONS

1. ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the Degree of Master of Science in Chemistry course shall be required to have passed the B.Sc degree examination with Chemistry as the major subject of study of this University or an equivalent examination of some other University accepted by the syndicate. The candidate should have taken Mathematics and Physics as the allied subjects in their undergraduate course.

2. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study for a period of not less than two academic years, passed the examinations of all the four semesters prescribed and earned a total of 93 credits.

3. COURSE OF STUDY:

The main subject of study for Master's Degree in Chemistry shall consist of the following:

Courses	Number	Credit per course	Total Credits
Core Course:			
Theory	11	4	44
Project	1	4	4
Practicals	3	4	12
Elective Courses:			
Major	5	3-4	17
Non major	2	3	6
Soft Skill Courses	4	2	8
Internship	1	2	2
Total			93

4. PASSING MINIMUM:

A candidate shall be declared to have passed in each Theory / practical of the Core, Elective (Major and Non Major) subject of study wherever prescribed, if she secured not less than 50% of the marks prescribed for the end semester examination and also 50% in the sum of end semester examination and continuous assessment. There is no passing minimum for Continuous Assessment (CA). The maximum marks for CA is 40 and for End Semester examination is 60 (for theory, practicals and Project). The aggregate mark for each paper is 100.

5. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

Successful candidates passing the examination and securing the marks

- (i) 60 % and above and
- (ii) 50 % and above but below 60 % in the aggregate shall be declared to have passed the examination in the **FIRST CLASS** and **SECOND CLASS** respectively.

Candidates who pass all the examinations prescribed for the course in the **First appearance** itself alone are eligible for ranking.

6. ESE QUESTION PAPER PATTERN:

CORE and ELECTIVE (Major) Courses:

COMPONENT	NATURE OF THE QUESTION	MAXIMUM MARKS
Part A	Definition/Short answers	20
Part B	Understanding, Descriptions / Problems	40
Part C	Application / Analysis / Synthesis / Evaluation	40

Part A: All 10 questions to be answered each carrying 2 marks with 2 questions from each unit
[10Q x 2 = 20 MARKS]

Part B: All 5 questions to be answered [5Q x 8 = 40 marks] with an internal choice choosing one question from each unit

Part C: 2 questions to be answered out of 4 questions covering all the 5 units with a maximum of 4 subdivisions (a,b,c,d) [2Q x 20 = 40 marks]

ELECTIVE COURSE (Non Major):

COMPONENT	NATURE OF THE QUESTION	MAXIMUM MARKS
Part A	Understanding, Descriptions / Problems	40
Part B	Application / Analysis / Synthesis / Evaluation	60

Part A : 8 questions to be answered out of 10 questions covering all the 5 units
[8Q x 5 = 40 marks]

Part B: 6 questions to be answered out of 9 Questions covering all the 5 units
[6Q X 10 = 60 marks]

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The programme aims at producing Graduates who will be able to:

- PEO1:** Display higher order thinking in the knowledge domain and demonstrate professional skills
- PEO2:** Contribute to the advancement and application of relevant knowledge by self-directed learning
- PEO3:** Extend and integrate knowledge and skills to design and develop novel products and explore innovative solutions to national and international goals of development
- PEO4:** Exercise management skills and develop social interactions in a responsive, ethical and constructive way to meet global standards of excellence in all spheres of activity.
- PEO5:** Strive for social and economic equity based on the need for gender parity and ecological sustainability.

PROGRAMME OUTCOMES (POs):

On completion of the programme the students will be able to:

- PO1:** Acquire advanced conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline
- PO2:** Apply knowledge and critically evaluate the concepts and scientific developments to take up any challenge
- PO3:** Visualize and gain practical knowledge on multidisciplinary tasks related to current research in the fields of Mathematical, Physical and Life sciences
- PO4:** Acquire research skills so as to innovate, design, methods and techniques in Research/ Industrial field
- PO5:** Communicate effectively, present and publish scientific ideas in native and English language leading to Entrepreneurship ventures such as consultancy and training
- PO6:** Employ innovative and environment friendly methods, novel ideas to solve complex and challenging societal and environmental issues

PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of the specific programme the student will be able to:

- PSO1:** Acquire in-depth knowledge at an advanced level enabling confidence to face competitive examinations of national and global standards and capable of doing higher level research independently
- PSO2:** Utilize skills in problem solving, critical thinking and analytical reasoning in chemistry domain and use modern techniques, chemistry software to interpret and design scientific processes
- PSO3:** Enhance Skill in planning and conducting advanced level chemical experiments, elucidating the structure of compounds / complexes using chemical characterization techniques
- PSO4:** Develop a creative scientific mind to communicate effectively in public forum-scientific ideas and their impact on socio-economic issues and also provide value based ethical leadership and sensitize the need for a green environment
- PSO5:** Apply the contextual knowledge of chemistry to function effectively as an individual / team leader / entrepreneur in academic field, chemical or related industries.

M.Sc. CHEMISTRY
(Syllabus effective from the year 2021-2022)

1. OBJECTIVES OF THE COURSE:

- (i) To provide an advanced knowledge in Chemistry and also expose the students to research.
- (ii) To have a career in the following areas after completion of the course with a M.Sc., degree in Chemistry
 - (a) a teaching career in a college for science and engineering courses.
 - (b) a high profile job in a scientific laboratory / R&D Departments / Chemical industry.
 - (c) a research career in an academic institution or a National Institute / Laboratory.
 - (d) to start one's own industry and be an entrepreneur.
- (iii) All the topics in the NET/SLET syllabus for Chemistry are incorporated as passing the NET/SLET is a pre-requisite for UGC/CSIR Research Fellowship, for recruitment of college teachers and an added qualification for many research positions.

2. PREAMBLE:

- Modification of course contents in few courses based on feedback from students and report given by Academic audit members.
- 5 Elective - (Major) -courses on the current topics.
- Project based on current topics.
- Two self-study papers (any one) in Semester III for Advanced learners
- Practical Examination conducted at the end of even semester
- Internship at the end of the II semester.
- Four soft skills course one in each semester
- Two Non major electives courses one each in II and III semester.

3. COURSE PROFILE:

Total Credits: 93

Core	:	60	(Theory& Practical 56 +Project 4)
Major Elective	:	17	
Non major elective :		06	
Soft skills	:	08	
Internship	:	02	

Semester	I	II	III	IV
Credits	18	30	20	25

COURSE PROFILE

SEMESTER - I											
Course code	Course title	L	T	P	Total Hours /week	TOTAL HOURS	Credit	Exam Hrs	MARKS		
									CA	SE	TOTAL
6P21/1C/OC1	Core 1- Organic Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1C/IC1	Core 2 - Inorganic Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1C/PC1	Core 3 - Physical Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1E1/NAC	Major Elective 1- Nano Chemistry	4	1	0	5	75	4	3	40	60	100
	*Core Practical-1- Organic Chemistry				4	120					
	*Core Practical -2- Inorganic Chemistry				4	120					
PG21/1S/PDT	Soft skill 1 - Personality Enrichment for Women	2	0	0	2	30	2	2		50	50

SEMESTER - II											
Course code	Course title	L	T	P	Total Hours /week	TOTAL HOURS	Credit	Exam Hrs	MARKS		
									CA	SE	TOTAL
6P21/2C/OC2	Core 4 - Organic Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2C/IC2	Core 5 - Inorganic Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2C/PC2	Core 6 - Physical Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2E2/SAC	Major Elective 2 - Spectroscopic Analysis of Chemical Structure	3	1	0	4	60	3	3	40	60	100
6P21/2E/COS	Non Major Elective 1 - Cosmetology	3	1	0	4	60	3	3	40	60	100
6P21/2C/PR1	*Core 7 - Practical -1 Organic Chemistry				4	120	4	6	40	60	100
6P21/2C/PR2	*Core 8 - Practical -2 - Inorganic Chemistry				4	120	4	6	40	60	100
PG21/2S/LCE	Soft skill- 2 Language and Communication in English/	2	0	0	2	30	2	2		50	50
PG21/2S/FRE	Soft Skill in French/										
PG21/2S/GER	Soft Skill in German										
	Total				30		28				

SEMESTER - III

Course Code	Course title	L	T	P	Hours/ Week	Credits	TOTAL HOURS	Exam Hours	Marks		
									CA	SE	Total
6P21/3C/OC3	Core 9 - Organic Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3C/IC3	Core 10 - Inorganic Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3C/PC3	Core 11- Physical Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3E3/PHC	Major Elective 3- PhotoChemistry	3	1	0	4	3	60	3	40	60	100
6P21/3E/FDP	Non Major Elective -2 Fibre Fabrics , Dyeing and Printing of Textiles	3	1	0	4	3	60	3	40	60	100
6P21/3S/AAT	**Self- Study Paper for Advanced learners- Advanced analytical Tools for micro and nano structural analysis					2					100
6P21/3S/BIS	OR **Self- Study Paper for Advanced learners- BioInorganic and Supramolecular Chemistry					2					100
6P21/4C/PR3	*Core Practical III - Physical Chemistry				4		120		40	60	100
	*Core - Project				4	-	-	-	40	60	100
6P21/3S/LSS	Soft Skill 3- Laboratory Safety Skills	2	0	0	2	2	30	2		50	50
6P21/3I/INT	Internship	-	-	-		2					
Total					30	22					

SEMESTER - IV											
Course Code	Course title	L	T	P	Hours /Week	Credits	TOTAL HOURS	Exam Hours	Marks		
									CA	SE	Total
6P21/4C/OC4	Core 12 - Organic Chemistry - IV	4	1	0	5	4	75	3	40	60	100
6P21/4C/IC4	Core 13 - Inorganic Chemistry - IV	4	1	0	5	4	75	3	40	60	100
6P21/4E4/ECC	Major Elective 4 - Electrochemistry and Computational Chemistry	4	1	0	5	4	75	3	40	60	100
6P21/4E5/POC	Major Elective 5 - Polymer Chemistry	3	1	0	4	3	60	3	40	60	100
6P21/4C/PR3	*Core 14 Practical III - Physical Chemistry				4	4	120	6	40	60	100
6P21/4C/PRO	*Core 15 - Project	-	-	-	5	4	-	-	40	60	100
6P21/4S/SRP	Soft Skill 4- Scientific Research and Presentation Skills	2	0	0	2	2	30	2		50	50
		Total			30	25					
		Total Credits				93					

EVALUATION PATTERN

Theory & Practical

CA Marks	:	40
End Semester Examination Marks	:	60
Total Marks	:	100

Theory: Continuous Assessment (CA)

Pattern for Continuous Assessment

			CA marks
Test I	2hrs.	50 marks	10
Test II	2hrs.	50 marks	10
Quiz/ Assignment/ Seminar/ Field visit			10
Participatory Learning			10
Total			40 marks

Practical Continuous Assessment (CA):

(a)	One Test	-	10 marks
(b)	Skill in practical	-	10 marks
(c)	Viva -Voce	-	10 marks
(d)	Record	-	10 marks

40 Marks

End Semester Examination questions are to be chosen from the question bank by the External Examiner and evaluated by both Internal and External Examiners.

Pattern for Project Evaluation

- | | |
|-------------------------------------------|------------|
| a) Review report & Viva Voce Presentation | - 60 marks |
| b) Project CA | - 40 marks |

100 marks

RUBRICS FOR CONTINUOUS ASSESSMENT

Assignment: Appearance, contents, originality, presentation, schematic representation and diagram, bibliography.

Seminar: Organization, subject knowledge, visual aids, confidence level, presentation.

Participatory learning: Answering questions, clearing doubts, participation in discussion, attendance, communication and language.

Field trip: Participation, Preparation, respect, attitude, leadership.

Project: Preliminary work, design, content, presentation.

Flipped/ Blended Learning - Information exchange, Group interaction, clearing doubts

End Semester Examination question papers are to be set by the External Examiners and evaluated by both Internal and External Examiners. Duration of End semester examination is 3 hours and maximum mark is 100.

RUBRICS FOR SELF STUDY PAPER

Students with distinction in I year of study with no arrears are eligible to take self-study paper.

The self-study paper is optional and 2 extra credits are given.

No Continuous assessment

Question paper will be set by the department. Single evaluation is done.

RUBRICS FOR INTERNSHIP

Internship is to be done at the end of second Semester for a period of 14 days during summer holidays and a detailed internship report to be submitted with completion certificate.

CA- Question Paper Pattern PG- Core

Knowledge level	Section	Word Limit	Marks	Total
K1	A - 7 x 2 Marks	One or Two Sentences	14	50
K1, K2	B - 2/3 x 8 Marks	250	16	
K2, K3	C - 1/2 x 20 Marks	500	20	

CA- Question Paper Pattern PG -Non Major Elective

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	A - 4/6 x 5 Marks	250	20	50
K3, K4	B - 3/5 x 10 Marks	500	30	

COURSE PROFILE

SEMESTER - I											
Course code	Course title	L	T	P	Total Hours /week	TOTAL HOURS	Credit	Exam Hrs	MARKS		
									CA	SE	TOTAL
6P21/1C/OC1	Core 1- Organic Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1C/IC1	Core 2 - Inorganic Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1C/PC1	Core 3 - Physical Chemistry - I	4	1	0	5	75	4	3	40	60	100
6P21/1E1/NAC	Major Elective 1- Nano Chemistry	4	1	0	5	75	4	3	40	60	100
	*Core Practical-1- Organic Chemistry				4	120					
	*Core Practical -2- Inorganic Chemistry				4	120					
PG21/1S/PDT	Soft skill 1 - Personality Enrichment for Women	2	0	0	2	30	2	2		50	50

L = Lecture hours, T = Tutorial hours, P = Practical hours

CA = Continuous Assessment marks, SE = End semester Marks

***Practical Examinations are conducted once in a Academic year - at the end of II & IV Semester**

Note: Students can take up NPTEL/ MOOC courses and earn extra credits

SEMESTER - I

Title of the Course: Core 1- Organic Chemistry- I

Teaching Hours: 15 x 5 = 75

C

redits: 4

Course Code: 6P21/1C/OC1

LTP 4 1 0

Objectives:

1. To study the concepts in Optical isomerism and Asymmetric synthesis
2. To study the concepts of Pro-chirality – Pro-stereoisomerism
3. To study the conformation and stereoisomerism of cyclohexane, decalins and their relationship with reactivity
4. To study Linear free energy relationships and Neighboring group participation
5. To study the mechanisms and stereochemistry of Elimination reactions.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Classify chiral molecules as dissymmetric / asymmetric and assign R/S configuration. Apply the concept and principles of asymmetric synthesis and propose syntheses of molecules of reasonable complexity with control of stereochemistry.
CO 2	Predict number of stereo isomers in molecules; assign E/Z nomenclature and topical relationship to organic molecules. Analyse and identify stereospecific, stereoselective, regioselective, chemoselective and regiospecific reactions
CO 3	Discuss Conformations of mono- and di-substituted cyclohexanes and decalins. Compare the relationship between conformation and reactivity
CO 4	Formulate methodologies for determining reaction mechanism and energetic of the reaction. Apply concept of NGP to bicyclic systems. Use of LFER to explain effect of substituents on reaction rates.
CO 5	Explain mechanism and stereochemistry of elimination reactions in simple and cyclohexane ring systems. Predict major and minor product of elimination reactions, identify reaction parameters to drive reaction towards substitution / elimination.

COURSE OUTLINE

UNIT I: Optical isomerism: Stereochemistry and conformational analysis: Optical activity and chirality, classification of chiral molecules as asymmetric and dissymmetric. A brief study of dissymmetry of allenes, biphenyls, spiro compounds, trans-cyclooctene, cyclononene and molecules with helical structures- hexahelicene. Absolute configuration - D, L and R, S- notations of biphenyls and allenes. Saw horse, Newmann and Fischer projection representations and interconversion (restricted to molecules with one to five asymmetric carbon atoms). Erythro and threo nomenclature, Asymmetric synthesis and Absolute asymmetric synthesis - Principle Categories of asymmetric synthesis - Chiral substrate, Chiral reagents-

Asymmetric hydroboration, Chiral auxiliary -derived from Proline, Menthol, modification of Lithium Aluminium Hydride - BINAL - H- application in reduction of enantiotopic ketone, Chiral catalyst - Sharpless asymmetric epoxidation, Chiral Wilkinson catalyst, enantioselectivity, diastereoselectivity, Optical Purity, Cram's rule and Prelog's rule.

15 hrs

- UNIT II: Geometrical isomerism:** E, Z nomenclature of olefins. Geometrical and optical isomerism of disubstituted cyclopropane, cyclobutane and cyclopentane. Identification- enantiotopic, homotopic, diastereotopic ligands and faces and prochiral carbons and nomenclature of enantiotopic hydrogens. Stereospecific and stereoselective synthesis. Chemoselectivity, regioselectivity and regiospecificity. **15 hrs**
- UNIT III: Conformational analysis:** Conformational analysis of cyclohexane and mono-di-substituted cyclohexanes and their stereochemical features (Geometrical and optical isomerism if shown by their derivatives), conformation and reactivity of substituted cyclohexanols (oxidation and acylation) and cyclohexane carboxylic acid derivatives (esterification and hydrolysis) conformation and stereochemistry of cis and trans decalin and 9-methyldecalin, decalones. **15 hrs**
- UNIT IV: Reaction Mechanism:** Kinetic and non-kinetic methods of determining organic reaction mechanisms. Kinetic and thermodynamic controlled products. Neighbouring group participation - Substitution in norbornyl and bridge head systems, Reactivity, structural and solvent effects in substitution reactions. Hammett equation- simple problems and Taft equation, substitution at allylic and vinylic carbons, substitution by ambident nucleophiles-such as CN, NO₂, phenoxide and ambident dianions. Williamson's reaction, Von- Braun reaction, Dieckman condensation and Claisen condensation. **15 hrs**
- UNIT V: Elimination:** E1-E2-EI_{cb} spectrum orientation of the double bond- Hofmann and Saytzeff rule. Competition between elimination and substitution. Stereochemistry of E2 eliminations, Elimination in cyclohexane ring system. Mechanism of Pyrolytic eliminations. Examples- Chugaev reactions and Cope elimination, Hofmann degradation, pyrolysis of esters. **15 hrs**

RECOMMENDED TEXTBOOKS:

1. Jerry March Advanced organic Chemistry, 6th edn. John Wiley and Sons, Inc.1992
2. Ernest Eliel, Stereochemistry of carbon compounds, 1st John Wiley and Sons
3. I.L. Finar, Organic Chemistry Vol I, 5th edn ELBS
4. I.L. Finar, Organic Chemistry Vol II, 5th edn ELBS

REFERENCE BOOKS:

1. Neil Isaac, Physical organic Chemistry, ELBS publication. 2 edn Longmann 1995
2. Stanley H.Pine, Organic Chemistry, 5th edn Mac Graw Hill 1987
3. E.S.Gould, Mechanism and Structure in Organic Chemistry
4. Francis A.Carey and Richard, Advanced organic Chemistry, Part A & B by 5 edn J.Sundberg

Plenum Press

5. P.S.Kalsi, Stereochemistry, conformation and mechanism, 7th Wiley Eastern Ltd, Chennai.
6. D.Nasipuri, Stereochemistry of organic compounds, principles and applications, 3rd Wiley Eastern Ltd.,
7. Petersykes, A Guide book to mechanism in organic Chemistry 5 edn John Wiley 1981
8. Y.R.T.Morrison, R.N.Boyd, Organic Chemistry VI edition, Prentice- Hall of India Pvt, New Delhi
9. G.Solomon, Organic Chemistry, C.B.Fryhle 8th edn, Wiley 2003

PERIODICALS:

1. Journal of Organic Chemistry
2. Indian Journal of Chemistry B
3. Current Science
4. Organic Letters
5. Tetrahedron Letters

WEBSITES & e-LEARNING SOURCES

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. *mooc.org*
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping: Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	1	2	2
CO 2	3	3	1	2	2
CO 3	3	3	1	2	2
CO 4	3	3	1	2	2
CO 5	3	3	1	2	2
Average	3	3	1	2	2

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1

No Correlation - 0

Teaching Methodology: Lecture (Chalk & Talk), Use of 3D models, Problem solving, Seminar, Quiz, Flipped learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER -I

Title of the course: Core-2 Inorganic Chemistry - I

Teaching hours: 15 x 5 = 75

Credits: 4

Course Code: 6P21/1C/IC1

L T P 4 1 0

Objectives:

1. To impart detailed knowledge in different aspects of coordination Chemistry
2. To understand the concepts of spin orbit coupling, micro states and term symbols of free ion
3. To show the importance of electronic transitions in metal complexes and their absorption spectra
4. To understand the outer and inner sphere reactions in coordination complexes
5. To impart the knowledge about the mechanism involved in substitution reaction in coordination complexes

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Discuss the application of CFT to various systems, describe the stability of metal complexes in terms of formation constant, calculate TD parameters, explain JT theorem and Nephelauxetic effect
CO 2	Demonstrate detailed functional knowledge about the symmetry, bonding in octahedral and tetrahedral systems, spin orbit coupling and derive term symbols of free ions
CO 3	Understand electronic transitions in metal complexes, interpret the spectra of coordination complexes and learn charge transfer spectra
CO 4	Explain different types of electron transfer reactions and factors governing them
CO 5	Evaluate and gain knowledge on the various mechanism of substitution reactions in coordination complexes

COURSE OUTLINE

UNIT I: Crystal field theory and its limitations: Application to octahedral and tetrahedral systems-Measurement of $10Dq$. Factors affecting crystal field splitting. Strong and weak field-Evidence in support of crystal field effect- Octahedral Vs Tetrahedral, Spinels-Normal, mixed and inverse spinel. Octahedral site stabilization energy- Jahn Teller distortion- Square planar complexes- Nephelauxetic effect- Evidence in favour of metal ligand orbital overlap. **15 hrs**

UNIT II: Molecular orbital theory: Octahedral and tetrahedral systems- construction of ligand group orbitals- site inspection -use of symmetry pi-bonding in octahedral system. Molecular orbital picture of square planar systems. Spin Orbit coupling - RS and jj coupling - micro states and term symbols. Terms of free ions. **15 hrs**

UNIT III: Splitting in octahedral and tetrahedral fields: Orgel and Tanabe Sugano diagrams- Electronic transitions in metal complexes- Analysis of electronic absorption spectra of complexes- selection rule-vibronic coupling-dp mixing- spin spin and spin orbit coupling- charge transfer spectra. **15 hrs**

UNIT IV: Electron transfer reactions: Outer sphere-exchange and cross reactions- Marcus equation-complementary and Non complementary electron transfers- inner sphere Bridging ligand-role-Resonance and radical mechanisms. **15 hrs**

UNIT V: Substitution reactions- Classification A, D and interchange mechanisms. Substitution in square planar complexes- influence of nature of leaving, entering groups and other ligands present on rate. Trans effect, cis effect, parallel path mechanisms-Evidence - substitution in octahedral complexes-anation-acid catalysed hydrolysis- Based catalysed-CB mechanism Evidence. **15 hrs**

RECOMMENDED TEXTBOOKS:

1. Inorganic Chemistry, F.Purcell and J.C.Kotz, W.B.Sounders & Co (1980)
2. Coordination Chemistry D Banerjee Tata McGraw Hill 1994
3. Inorganic Chemistry: Principles of Structure and Reactivity (4th Edition), 1997 by James, Ellen, Richard L. Keiter
4. Advanced inorganic Chemistry FA Cotton & G.W.Wilkinson, John Wiley & sons 1988
5. Coordination Chemistry -S.F.A.Kettle., ELBS 1973.
6. Coordination Chemistry - Basalo & Johnson
7. Inorganic Chemistry - Shriver & Atkins, oxford University press- 3rdedn 1999

REFERENCE BOOKS:

1. Mechanisms of Inorganic reactions- Basalo F.and R.G.Pearson, 2nd edn 1967, John Wiley
2. Inorganic reaction Mechanism, Tobe M.L.Nelson, London 1972
3. Ligand substitution processes, Langford C.H.and H.B.Gray, Benjamin Newyork 1965
4. Mechanisms of inorganic reactions in solution, Benson D McGrawHill London 1968
5. E.J.Corey and J.C.Bailar Jr- J.Am chem.Soc. 81, 2620 (1959)
6. J.R.Gollogly, C.J.Hawkins and J.K.Beattle, Inorg. chem., 10, 317 (1971)
7. Complexes of I row transition elements - D.Nicholos
8. Introduction to ligand fields- B.N.Figgis- John Wiley- New york 1966
9. Introduction to ligand field theory, Ballhausen C.J, McGrawHill, New york 1962

PERIODICALS:

1. Coordination Chemistry review
2. Inorganica Chimica acta
3. J.Coordination Chemistry
4. Current Science
5. Journal of Indian chemical society
6. Chemical society review
7. Polyhedron

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. **MATLAB**
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	2	2	2	2	2
CO 3	2	1	2	2	2
CO 4	3	1	2	1	1
CO 5	2	1	2	1	1
Average	2.4	1.6	2.2	1.8	1.8

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk & Talk) , Flipped learning , Seminar

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-I

Title of the course: Core 3-Physical Chemistry-I

Teaching hours: 15 *5 = 75

Credits: 4

Course code: 6P21/1C/PC1

L T P 4 1 0

Objectives:

1. To provide a significant knowledge in theories of chemical reactions, and its applications.
2. To study the kinetics of reactions and the effect of experimental parameters on it
3. To understand the significance and applications of Radiation Chemistry
4. To study the concepts of molecular and crystallographic symmetry
5. To apply the concepts of symmetry for the study of molecular bonding and spectroscopy.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Acquire in depth knowledge about theories of chemical kinetics and to calculate specific rate, activation energy and frequency factor.
CO 2	Calculate Michaelis Menton constant for enzyme - substrate binding by Lineweaver Burk plot.
CO 3	Analyze kinds of radiation utilised in several fields of research and industry
CO 4	Distinguish molecular and crystallographic symmetry, apply multi symmetry operations to derive character tables.
CO 5	Gain knowledge of symmetry based selection rules for vibrational and electronic spectroscopy and predict the spectra of molecules

COURSE OUTLINE

UNIT I: Chemical Kinetics-I: Theories of reactions-effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions -Lindemann and Christiansen hypothesis- molecular beams, collision cross sections, effectiveness of collisions, potential energy surfaces. Transition state theory -based on thermodynamic and statistical mechanics-partition functions and activated complex- Eyring equation, estimation of free energy, enthalpy and entropy of activation and their significance.

15 hrs

UNIT II: Chemical Kinetics-II: Reactions in solutions, reactions in ideal solutions, effect of pressure, Dielectric constant, ionic strength on rate of reactions in solution - primary salt effect and secondary salt effect, kinetic isotope effects, linear free energy relationships- Hammett and Taft equations-Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalysed reactions-Bronsted catalysis law, enzyme catalysis-Michaelis-Menten catalysis, Line Weaver - Burk method, influence of pH and temperature.

15 hrs

UNIT III: Radiation Chemistry: Range of radiations, interaction of γ radiation with matter

-photoelectric effect, Compton effect and pair production, neutrons through matter-elastic and inelastic scattering, significance, radiation dosimetry-Fricke dosimeter, ceric sulphate dosimeter, conversion of dose values, radiolysis of water, hydrated electron-methods of generation, properties, structure and uses. Radiometric titrations and applications. Radiation precautions. **15 hrs**

UNIT IV: Group Theory: Symmetry elements and symmetry operations, point groups-identification and determination, comparison of molecular symmetry with crystallographic symmetry, reducible and irreducible representations, direct product representation, Great Orthogonality theorem and its consequences, character tables- C_{2v} & C_{3v} **15 hrs**

UNIT V: Applications of Group Theory: Transition moment integrals, selection rule for spectral transitions. Symmetry selection rules for infra-red and Raman spectra. Determination of representations of vibrational modes in non-linear molecules H_2O , NH_3 , BF_3 - electronic spectra of ethylene and formaldehyde. SALC principle with example of C_{2v} point group. **15 hrs**

RECOMMENDED TEXT BOOKS:

1. K.J.Laidlar –Chemical Kinetics, Harper and Row, Newyork, 1987
2. J.Rajaram, J.C.Kuriacose- Kinetics of Mechanism of Chemical Transforamtions, Macmillan India Ltd., 1983
3. V. Ramakrishnan and M.S.Gopinathan – Group Theory in Chemistry, Vishal Publications, 1988
4. K.V.Raman- Group theory and its applications to Chemistry, Tata Mc Graw Hill Publishing Co., 1990
5. Essentials of Nuclear Chemistry, Arnikaar, Hari Jeevan, ISBN: 978-81-224-3203-9 (2011)

REFERENCE BOOKS:

1. W.J.Moore- Physical Chemistry, Orient Longmann, London, 1972
2. G.M.Barrow- Physical Chemistry, Mc Graw Hill, 1988R.
3. G.Frost and Pearson- Kinetics and Mechanism, Wiley Newyork, 1961.
4. C.Capellos and B.H.J.Bielski- Kinetic systems, Wiley inter science, Newyork 1972
5. G.M.Harris- Chemical Kinetics, D.C.Heath and Co., 1966
6. F.A.Cotton - Chemical Applications of Group theory, John Wiley and Sons Inc., Newyork 1971.
7. N.Tinkham- Group Theory and Quantum Mechanics, Mc Graw Hill Book Company, Newyork, 1964
8. D.S.Schonland - Molecular symmetry and Group theory- Programmed introduction to chemical application, Wiley, Newyork (1977)
9. Paul L Houston- Chemical Kinetics and Reaction dynamics, Dover publications (2006)
10. E.T.Denisov, O. M. Sarkinov and G.I.LikhLenshtein, Chemical Kinetics - Fundamentals and new Development by Elsevier publication 2003
11. B S Garg Chemical applications of molecular symmetry and group theory . Macmillan 2013

PERIODICALS:

1. Resonance- Journal of science education

2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. **MATLAB**
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>
7. <http://www.ch.ic.ac.uk/vchemlab/symmetry/>
8. <http://www.reciprocalnet.org/edumodules/symmetry/intro.html>
9. <http://www.win.tue.nl/~amc/ow/gpth/reader.pdf>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	1
CO 2	2	3	3	2	3
CO 3	2	3	1	1	2
CO 4	3	3	1	1	1
CO 5	3	3	2	1	1
Average	2.6	3	2	1.6	1.6

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk & Talk), Power Point presentation, Sharing online interactive sessions, videos in the classroom, sharing web links

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
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K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-I

Title of the course: Major Elective 1- Nano Chemistry

Teaching hours: 15 x5= 75

Credits: 4

Course Code: 6P21/1E1/NAC

L T P 4 1 0

Objectives:

1. To introduce and give an insight into the fascinating area of nanoscience & its development.
2. To learn the experimental techniques of nanoscale synthesis.
3. To understand the tools of characterization of nano scale features.
4. To correlate the variation of properties upon size.
5. To study the applications of Nano materials.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Learn the size dependent property of materials, classify and connect them with nature
CO 2	Gain in depth knowledge of laboratory and technology-based synthesis of nano materials and evaluate them based on application and design
CO 3	Analyze the unique properties of the nano scale materials in comparison with their macro and micro scale levels
CO 4	Correlate the nano scale properties with their spectroscopic and microscopic data and draw conclusion on their microstructure and morphology
CO 5	Compare and contrast the wider range of applications of nano materials in terms of energy, environment and medicine.

COURSE OUTLINE

UNIT I: Background to nanoscience and nanotechnology: Scientific revolutions, nanosized effects- surface to volume ratio- Quantum size effects- energy at the nanoscale molecular and atomic size-, Types of nanotechnology and nano machines. Definition of nano system based on dimensionality - zero D-quantum dots, 1D-Nano tubes, CNT and Nano wire, 2D-Graphene structure and their functionalization, Nanomaterials-Fillers, fibres, Fluids, Nano clays-types. **15 hrs**

UNIT II: Experimental Techniques and Separation: Mechanical methods: grinding high energy ball milling-types of balls-WC and ZrO₂-material-ball ratio medium for grinding. Physical methods: Vapour deposition and different types of epitaxial growth techniques- Pulsed Laser deposition, magnetron sputtering-micro- Lithography, Photolithography, soft lithography e-beam writing, laser ablation- RF/DC magnetron sputtering-microwave and Sonochemical method of combustion, control of grain size-scale up process. Chemical methods: Sol-gel technique- Solvo- thermal methods-Co-precipitation, hydrolysis, colloidal precipitation template process, Biological nano synthesis using plants and microorganisms. **15hrs**

- UNIT III: Characterization using Analytical tools:** Applications of UV-Vis, NIR, FTIR, FT-Raman, photoluminescence, Light scattering method. X-ray characterization of nano materials- Powder X-ray diffraction- Crystallite size determination- Scherrer equation, Micro structure analysis, use of JCPDS, determination of crystal systems- accurate lattice parameters. X ray Photoelectron spectroscopy (XPS). Electron Microscopy- Scanning Electron and Transmission Electron Microscopy (SEM & TEM), Atomic Force Microscopy (AFM). **15 hrs**
- UNIT IV: Properties at the Nano scale:** Electrical properties- electrical conductivity, super conductance, Optical properties absorption and luminescence, Magnetic Properties- Para, Dia, Ferro and Ferri magnetism, Super Para magnetism- SPIONS, Mechanical properties - micro hardness, fracture toughness, plastic nature . **15 hrs**
- UNIT V: Applications:** Nano Ceramics and Composites: membranes for purification of water, Hydroxyapatite - tooth and bone substitute-inductive bone replacements of ceramic valves. Nano catalysis, Nano electronic systems - MEMS and NEMS (basic principle only), Capping and Caging system-dendrimers Environmental applications- bio mediation-removal of microbes, bio medical applications - detection of malignancy and treatment, Sensors for DNA, proteins, Nano toxicology. **15 hrs**

RECOMMENDED TEXTBOOKS:

1. Nanoscience and Nanotechnology: Fundamental to Frontiers, M.S.Ramachandra Rao and Shubra Singh, Wiley Publications, 2013.
2. Textbook of Nanoscience and Nanotechnology, B.S.Murty, P.Shankar, Baldev Raj, B.B.Rath and James Murday ebook, Springer, University Press. 2013.
3. Nanoscale materials in Chemistry, Kenneth, J. Klabunde willey Interscience, 2001
4. Nano: The essentials, T. Pradeep Tata McGraw-Hill Publishing Company Limited, 2007.

REFERENCE BOOKS:

1. Nano and Microelectromechanical Systems: Fundamentals of Nano and microengineering, Sergy Lyshevski, Vallabh publications 2/e 2005.
2. Nanotechnology Environmental application and Solutions, Lious Theodore, Robert g.Kunz palgrave macmillan 2005.
3. Nanostructure& Nanomaterials: Synthesis, Properties & Applications, G. Cao, Imperial College Press, 2004.
4. Nanomaterials, Nanotechnologoes and Design: An introduction for Engineers and Architects, Micheal F. Ashby. P.J. Ferria. D.L. Schodekpalgrave macmillan 2005.
5. C.N.R. Rao, A. Muller, A.K. Cheetam (Eds), The Chemistry of Nanomaterials, Vol.1, 2, Wiley - VCH, Weinheim, 2004.
6. C.P. Poole, Jr: F.J. Owens, Introduction to Nanotechnology Wiley Interscience, New Jersey, 2003
7. Kenneth J. Klabunde (Ed), Nanoscale materials in Chemistry, Wiley- Interscience, New York, 2001.

PERIODICALS:

1. Current Science
2. Journal of nanotechnology
3. Journal of nanomaterials

WEBSITES & e-LEARNING SOURCES:

1. <http://search.ebscohost.com>
2. <http://nisenet.org/>
3. <http://www.nanoparticles.org/nano%20links/>
4. <http://www.nsti.org/>
5. <http://nanozone.org/>
6. <http://www.understandingnano.com/>
7. <http://www.nanoparticles.org/nano%20links/>
8. <http://www.nanotechweb.org/>
9. http://www.pionline.com/pdf/forum/pi_20060318_apsgb.pdf
10. <https://www.azonano.com/>
11. <https://www.nanowerk.com/>
12. <http://www.nanotech-now.com/current-months-press.htm>
13. <https://www.nano.gov/>
14. <https://www.nanotechmag.com/>
15. <https://www.nature.com/nnano/>

Mapping: Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	1	2
CO 2	3	3	3	2	2
CO 3	3	3	3	2	2
CO 4	3	3	3	2	1
CO 5	2	3	3	2	3
Average	2.8	3	2.8	1.8	2

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1

No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Power Point presentation, Sharing online interactive sessions in the classroom, Sharing web links.

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER - II											
Course code	Course title	L	T	P	Total Hours /week	TOTAL HOURS	Credit	Exam Hrs	MARKS		
									CA	SE	TOTAL
6P21/2C/OC2	Core 4 - Organic Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2C/IC2	Core 5 - Inorganic Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2C/PC2	Core 6 - Physical Chemistry - II	3	1	0	4	60	4	3	40	60	100
6P21/2E2/SAC	Major Elective 2 - Spectroscopic Analysis of Chemical Structure	3	1	0	4	60	3	3	40	60	100
6P21/2E/COS	Non Major Elective 1 - Cosmetology	3	1	0	4	60	3	3	40	60	100
6P21/2C/PR1	*Core 7 - Practical -1 Organic Chemistry				4	120	4	6	40	60	100
6P21/2C/PR2	*Core 8 - Practical -2 - Inorganic Chemistry				4	120	4	6	40	60	100
PG21/2S/LCE	Soft skill- 2 Language and Communication in English/ Soft Skill in French/ Soft Skill in German	2	0	0	2	30	2	2		50	50
PG21/2S/FRE											
PG21/2S/GER											
Total					30		28				

L = Lecture hours, T = Tutorial hours, P = Practical hours, CA = Continuous Assessment marks, SE = End semester Marks*Practical Examinations are conducted once in a Academic year ie at the end of II & IV Semester

SEMESTER - II
Title of the course: Core 4-Organic Chemistry-II

Teaching hours: 15 x 4 = 60

Credits: 4

Course Code: 6P21/2C/OC2

L T P 3 1 0

Objectives:

1. To provide an understanding of the mechanisms of important oxidation reactions using different reagents
2. To study the reactions of reactive intermediates viz carbenes and nitrenes,
3. To study some important rearrangements in organic chemistry.
4. To study the generation of free radicals and aromatic radical substitution reactions
5. To study the mechanism of reduction reaction using different reducing agents.

Course Outcomes:

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

CO No.	CO Statement
CO 1	Understand the mechanism and stereochemistry of oxidation of organic compounds with reagents like PCC,PDC, Collins reagent, Prevost and Woodward method of hydroxylation of alkenes and oxidative cleavage of C—C single and double bond.
CO 2	Explain mechanism and stereochemistry of reduction of organic compounds with various reagent like LiAlH ₄ NaBH ₄ ,trialkyl hydride etc Name reactions - Clemmensen, MPV. Wolf—kishner, Birch reduction and selectivity in reduction
CO 3	Explain preparation ,structure , reactions and stereochemical aspects of reactive intermediates like. carbanion, carbocation, carbenes and nitrenes used in organic synthesis
CO 4	Outline the mechanism of free radical addition to olefin, aromatic radical substitution reactions and understand preparation and trapping of aryne intermediates
CO5	Explain mechanism and stereochemistry of rearrangement reactions - Wagner Meerwein, Demjanov, Dienone- Phenol, Von-Richter, Baeyer- Vileger, Favorskii and Steven rearrangement, its applications to other molecules

COURSE OUTLINE

- UNIT I: Oxidation:** Mechanism of oxidation of alcohols & aldehydes with Cr (VI) & Mn (VII) oxidants; Oxidation of C=C and C-H bonds; Uses of PCC, PDC and Collin's reagent. Peroxy oxidations-Alkene epoxidation by peracids and metal/alkyl hydroperoxides. oxidation of methylene to carbonyl, oxidation of arylmethanes- allylic oxidation of olefins, Oppenauer oxidation; Prevost and Woodward hydroxylation of alkenes; Oxidative cleavage of C-C single and double bonds; Periodates, LTA and Osmium tetroxide. **12 hrs**
- UNIT II: Reduction:** Selectivity in reduction of 4-t-butylcyclohexanone using selectrides-hydride reductions, Clemmensen, Wolf-Kishner reductions- Modification of Wolff-Kishner reduction, Birch reduction, MPV reduction, Catalytic hydrogenation and selectivity in reduction Reduction with LiAlH_4 , NaBH_4 tritertiarybutoxyaluminium hydride, sodium cyanoborohydride, trialkyltin hydride, Acyloin condensation. **12 hrs**
- UNIT III: Reactive Intermediates Carbenes:** Stability, structure and spin states of carbenes; Cyclopropanation-spindependence and stereoChemistry; Carbene insertion to C-H bonds; Rearrangement to alkenes, Wolff rearrangement .Simmon - Smith reaction. **Nitrenes:** Stability, structure and spin states of nitrenes; C-H bond insertions and aziridine formation; Rearrangement of acylnitrenes (Hoffmann, Curtius and Schmidt reactions with applications in organic synthesis). **12 hrs**
- UNIT IV: Free radicals:** Long lived and short lived free radicals, methods of generation of free radicals. Addition of free radicals to the olefinic double bonds. The following aromatic radical substitutions are to be studied. Sandmeyer reaction, Gomberg- Bachmann reaction, Pschorr reaction Ulmann reaction, Mechanism of Hunsdieker reaction and Barton deoxygenation. **Aryne** -Methods of generation of benzyne intermediate, and trapping of aryne intermediate **12 hrs**
- UNIT V: Molecular Rearrangements:** Migratory aptitudes: A detailed study of the molecular rearrangemnts mechanism of the following rearrangements: Wagner Meerwein Rearrangements, Demjanov, dienone-phenol, Baeyer-Villegier, Favorski, Steven, and Von-Richter re-arrangements, Sommllet-Hauser, (A few examples in each re-arrangement are to be studied). **12 hrs**

RECOMMENDED TEXT BOOKS:

1. Organic Chemistry V Edition (1986) 5th Vol I by I.L.Finar, ELBS Publication
2. Advanced Organic Chemistry, 4th Edition by Jerry March, Wiley Eastern Ltd., New Delhi
3. Principles of organic synthesis R.O.C. Norman, Chapman and Hall, London. 2nd edition 1980.
4. Peter Sykes, A guide book to mechanism in organic Chemistry 5th edn John Wiley 1981

REFERENCE BOOKS:

1. Advanced Organic Chemistry by Francis A.Carey and Richard J.Sundberg, 5th Edition plenum press, New york (1990), Part A& B
2. Organic Chemistry, 6thedn(1992), Y.R.T.Morrison, R.N.Boyd, prentic-Hall of India Pvt.. New Delhi

- Mechanism and Structure in organic Chemistry by E.S.Gould
- Carbenes, Nitrenes and Arynes by T.L. Gilchrist and C.W. Rees, Thomas Nelson and Sons Ltd., London 1st edition
- Organic Reaction Mechanism by S.M. Mukherji and S.P. Singh, MacMillan India Ltd., 3rd Chennai (1990)
- StereoChemistry and Mechanism through solved problems by P.S. Kalsi.7th Wiley Eastern Ltd., (1994)

PERIODICALS:

- Journal of Organic Chemistry
- Indian Journal of Chemistry B
- Current Science
- Organic
- Tetrahedron Letters

WEBSITES & e-LEARNING SOURCES:

- www.virtlab.com
- <http://nptel.ac.in>
- MATLAB*
- mooc.org
- <http://swayam.gov.in>
- <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	2	2
CO 2	3	2	3	2	3
CO 3	3	3	2	2	2
CO 4	3	3	2	3	2
CO 5	3	2	2	3	2
Average	3	2.6	2.2	2.4	2.2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology : Lecture (Chalk & Talk) , Problem solving, Seminar, Quiz , Flipped learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-II

Title of the course: Core-5 Inorganic Chemistry-II

Teaching hours: 15x4 = 60

Credits: 4

Course Code: 6P21/2C/IC2

L T P 3 1 0

Objective:

1. To introduce different boranes and carboranes and important aspects of structural Inorganic chemistry.
2. To study the important aspects of solid state chemistry
3. To bring out the significance of solid state defects
4. To study the magnetic properties of transition metal complex
5. To study novel inorganic compounds

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Learn structure, bonding, stability and reactivity of simple boranes, carboranes and metallo carboranes
CO 2	Explain structural aspects of metallic clusters and polyanions of important compounds
CO 3	Explain different cubic systems, application of Bragg's equation and X-ray powder method in identifying inorganic crystalline solids
CO 4	Identify various crystal structures and their defects, learn principles and application of liquid crystals
CO 5	Understand Diffusion mechanism in solids, Band theory of solids, superconductors, Magnetic and optical properties of solids, concept of Hysteresis and determination of magnetic susceptibility by Guoy and Faraday methods

COURSE OUTLINE

- UNIT I: Structural aspects of boranes:** Different types of Boron hydrides-Nido, arachno and closo- Lipscomb's rule- structure and bonding in polyboranes- Reactions of polyboranes-carboranes and metallo carboranes-structure. **12 hrs**
- UNIT II: Structural aspects of metallic clusters and poly anions of important compounds.** Poly organophosphazenes, poly sulphur-nitrogen compounds structure-properties correlation. Iso and hetero poly anions of Vanadium, chromium, molybdenum and tungsten- structural aspects only. Metal clusters Binuclear and trinuclear clusters of Rhenium, Chromium, Molybdenum and Tungsten- Octahedral clusters- Metal only clusters structure and bonding only. **12 hrs**
- UNIT III: Solid state Chemistry I:** The Bravais Lattices - simple, body centered, face centered and end centered arrangements-slide axis-Glide planes- Space groups- Miller indices- Interplanar distances-Bragg's equation, x-ray powder data in identifying inorganic crystalline solids- details for cubic systems. Van Lane equation- Determination of structure. **12 hrs**

UNIT IV: Crystal Structure and defects: NaCl, CsCl, ZnS(Wurtzite & sphalarite), Diamond, Graphite, Nickel arsenide NiAs, Rutile, cadmium iodide, perovskite. Stoichiometric and Non stoichiometric defects- Schottky, Frenkel, Metal excess, Metal deficiency, line, plane defects- Shear planes, F centers. Non stoichiometric compounds. Photo Conductors: Principle and application-Liquid Crystals-Types and Applications
12 hrs

UNIT V: Diffusion in solids: Diffusion mechanisms- phase transitions, solid solutions, order disorder transformations and super structure formations, solid state electrolytes, solid state reactions- Band theory of solids- Semi conductors-p-n junctions- rectifiers, super conductivity-Meissner state-Type I & II super conductors- Magnetic properties of solids- para, ferro and antiferro magnetism- ferrites structure significance. Hysterisis-spin only magnetic moment- orbital contribution- systems with A,E and T ground terms. Determination of magnetic susceptibility by Guoy and Faraday methods- Optical properties of solids- Inorganic phosphors, Garnets, solid state Lasers.
12 hrs

RECOMMENDED TEXT BOOKS:

1. Principles of electronics V.K.Mehta & Rohit Mehta, Sultan chand & sons, 9th edn 2006
2. Solid State Chemistry and its Applications, 2nd Edition, Student Edition, Anthony R.West,2014 Wiley
3. Fundamentals of crystal Chemistry- TRN Kutty & JAK Tareen Universities Press (2001)
4. Introduction to solids L.V.Azaroff MacGraw Hill New york 1960
5. Elements of x-ray crystallography L.V.Azaroff, Mc.Graw-Hill Inc, New york (1968)
6. Inorganic solids D.M.Adams Wiley (New york) 1974
7. Inorganic Chemistry: Principles of Structure and Reactivity (4th Edition), 1997by James E. Huheey, Ellen A. Keiter , Richard L. Keiter
8. Advanced Inorganic Chemistry- A comprehensive text- F.A.Cotton & G.Wilkinson- John- Wiley V edn 1988
9. Structural principles in Inorganic compounds W.E.Addison John Wiley & Sons, New york (1961)
10. Modern aspects of inorganic Chemistry, H J Emeleus; A G S harpe 4th edn (1973)

REFERENCE BOOKS:

1. Structural inorganic Chemistry A.F.Wells., 5thedition, 2014 Clarendon press, oxford (1985)
2. Inorganic structural Chemistry.A.Miller Wiley, New york 1993
3. New directions in solid state Chemistry, CNR Rao and J.Gopalakrishnan, Cambridge University press (1997)

PERIODICALS:

1. Inorganica Chimica acta
2. Polyhedron
3. Chemical reviews
4. Current Science

5. Journal of Indian chemical society
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping :Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	2
CO 2	2	3	2	2	2
CO 3	3	3	2	2	1
CO 4	3	3	2	2	1
CO 5	2	2	2	2	1
Average	2.6	2.8	2.2	2.2	1.4

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology : Lecture (Chalk & Talk), Flipped learning, Seminar

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-II
Title of the course: Core-6 Physical Chemistry-II

Teaching hours: 15 x 4 = 60

Credits: 4

Course Code: 6P21/2C/PC2

L T P 3 1 0

Objectives:

1. To study the concepts and applications of quantum Chemistry
2. To study the approximation methods in quantum chemistry
3. To study chemical bonding in diatomic molecules and HMO theory
4. To study the kinetics of complex reactions and methods to study fast reactions
5. To study various adsorption isotherms and mechanisms of Heterogeneous catalytic reactions

COURSE OUTCOMES:

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

CO No.	CO Statement
CO 1	Analyze the need for quantum mechanics, relate quantum mechanical operators to observables and the use of operator algebra to solve simple eigen value equations, relate molecular phenomena viz translational, rotational and vibrational motion to model systems and solve Schrodinger equation to arrive at the eigen values
CO 2	Derive eigen values and wave functions of H and He atom using approximation methods. Concept of antisymmetric wave function and solve Hartree and Hartree Fock equation for helium atom
CO 3	Apply Molecular orbital and valence bond treatment to simple homonuclear diatomic molecules- H_2^+ & H_2 , MOT of higher diatomic molecules, HMO treatment of simple conjugated systems
CO 4	Gain knowledge about kinetics of complex reactions and fast reactions.
CO 5	Distinguish various adsorption isotherms and heterogeneous catalyst reactions.

COURSE OUTLINE

UNIT I: Quantum Chemistry I: Overview of wave equation for electrons, wave function and its physical meaning. Functions and operators- eigen function, eigen values, Hamiltonian operator, angular momentum operator- commutation of operators. Hermitian property of operators. Basic postulates of quantum mechanics. Application of quantum mechanics-particle in a 1D box, 3D box, simple harmonic oscillator, the rigid rotor, particle in a ring, hydrogen atom. Complete wave function of hydrogen like atoms. Significance of quantum numbers n,l,m. Physical representation of the orbitals, radial distribution, points of maximum probability, angular probability distribution . **12 hrs**

- UNIT II: Quantum Chemistry II:** Approximation methods-variation method and perturbation method-application to hydrogen and helium atom. Symmetric and anti-Symmetric wave function, general principles of setting up of wave function for many electron atoms- Pauli's principle -Slater type orbitals. Hartree and Hartree Fock SCF method. Angular momentum in many electron systems -Spin orbit interaction, L-S and j-j coupling schemes. **12 hrs**
- UNIT III: Quantum Chemistry III:** Chemical Bonding-Born-Oppenheimer approximation. VB and MO treatment of H₂ and H₂, MO theory for homo nuclear and hetero nuclear diatomic molecules. HMO calculations for simple molecules like ethylene, butadiene. Evaluation of co-efficients and eigen values for simple molecules, electron density, bond order and free valence index. **12 hrs**
- UNIT IV: Chemical Kinetics III:** Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. General treatment of chain reactions-chain length, kinetics of H₂ - Cl₂ & H₂ - Br₂ reactions - Rice Herzfeld mechanism, explosion limits. Study of fast reactions-relaxation methods- temperature and pressure jump methods, electric and magnetic field jump methods, stopped flow and flash photolysis methods. **12 hrs**
- UNIT V: Chemical kinetics IV:** Adsorption isotherms-Freundlich, Langmuir and BET adsorption isotherms, surface area-determination, BJH pore size determination- basic principle only, sticking probability, adsorption co-efficient and its significance Mechanism of heterogeneous catalytic reactions-Langmuir- Hinshelwood, Langmuir-Rideal mechanism-unimolecular and bimolecular surface reactions. Catalysis by metals and semiconductor oxides. **12 hrs**

RECOMMENDED TEXT BOOKS:

1. Quantum Mechanics in Chemistry, R.K. Prasad Wiley Eastern, New Delhi 1992
2. Quantum Mechanics in Chemistry, M.W.Hanna W.A.Benjamin Inc., London,
3. K.J.Laidler -Chemical Kinetics, Harper and Row, Newyork, 1987 J.Rajaram
4. J.C.Kuriacose- Kinetics of Mechanism of Chemical Transforamtions, Macmillan India Ltd., 1983

REFERENCE BOOKS:

1. A.K.Chandra- Introductory Quantum Chemistry, Tata Mc Graw Hill.
2. Quantum Chemistry, D.A.Mc Quarrie University Science Books, Mill Valley California, 1983
3. Molecular Quantum Mechanics, P.W.Atkins Oxford University Press, Oxford, 1989
4. W.J.Moore- Physical Chemistry, Orient Longmann, London, 1972
5. Physical Chemistry Volume 1: Thermodynamics and Kinetics, Peter Atkins, Julio de Paula, 9th edition.
6. Physical Chemistry, G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. MATLAB
4. Mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>
7. <http://antoine.frostburg.edu/chem/senese/101/quantum/index.shtml>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	2	2	2	1
CO 2	3	2	3	2	1
CO 3	3	2	3	2	1
CO 4	3	2	3	2	1
CO 5	3	2	2	2	1
Average	3	2	2.6	2	1

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (CHALK & TALK), Power Point presentation, Sharing online interactive sessions, videos in the classroom, Sharing web links

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-II

Title of the course: Major Elective 2 Spectroscopic Analysis of Chemical Structure

Teaching hours: 15 x 4 =60

Credits: 3

Course Code: 6P21/2E2/SAC

L T P 3 1 0

Objectives:

1. To understand the concepts of IR, UV, Raman, Mass, PES, NMR, EPR, Mossbauer spectroscopy
2. To learn the principles of the techniques
3. To apply the fundamentals to various systems
4. To study the applications of the tools
5. To determine the structure of organic and inorganic compounds

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Learn the principle of Infra-red and Raman spectroscopy, correlate with the molecular modes of vibration and apply the rules to interpret the spectra of organic and inorganic molecules
CO 2	Learn the concept and rules of electronic transitions in organic molecules and their correlation with UV absorption and emission spectroscopy
CO 3	Learn the principles and application of spin resonance of electron and nuclei of H, C,P, F in terms of EPR and NMR spectroscopy respectively for structural elucidation
CO 4	Analyze and apply the rules of Mass spectroscopy for the fragmentation pattern in different types of organic functional groups
CO 5	Learn the skill to decode the Photo electron and x ray Photo electron spectra in terms of binding energy, spin orbit coupling and spin - spin coupling

COURSE OUTLINE

UNIT I: Infrared Spectroscopy: Overview of the basic principles- structural factors affecting the vibrational frequencies and intensities- Effect of hydrogen bonding and solvent effect. Selection rule-Normal coordinate analysis (brief outline)-Base line correction-standard for calibration of the instrument -Application of IR to complexes of metals with isocyanides, carbonyls and nitrosyls. Different modes of binding of acetate, thioacetate and DMSO.Urea (amides) and amino acids, DMG as a ligand. Ethylene and acetylene complexes, Evidence for extensive pi bonding in these complexes. Isotopic labeling D², N¹⁵ and C¹³ and applications. **12 hrs**

- UNIT II:** UV absorption Spectroscopy: Beer- Lambert law, Electronic spectra of diatomic and polyatomic molecules - Franck - Condon principle - determination of dissociation energy - predissociation spectra - selection rules- types of electronic transitions - effect of conjugation and solvent - chromophores. Auxochromes, Bathochromic and Hypsochromic shifts. Applications in organic structure determination - Woodward - Feiser rules for conjugate systems and unsaturated ketones. Raman Spectroscopy: Overview of Stokes, Antistokes lines and Rayleigh scattering, polarisability ellipsoids-polarization of scattered radiation- depolarization ratio-Assignment of bands-Laser Raman-Ruby Laser-Instrumentation -Resonance Raman effect, Application- Study of solution equilibria-Detection of dimeric species like Hg_2^{2+} , N_2O_2 . **12 hrs**
- UNIT III:** Mass Spectrometry: Basic principles. Electron Impact technique- EI CI, FD Mass spectrometry-Field desorption-FAB and SIMS-Mass analyzer,-Mass spectrometers - isotopic peaks-Molecular ion,Fragment ions,Meta stable peaks-McLafferty rearrangement-Fragmentation pattern in aromatic alcohols, phenols, Toluene, aldehydes and ketones, carboxylic acids, amines and their derivatives. Photo electron spectroscopy: Introduction-Overview of principles and instrumentation of UV/XPES Instrumentation. MO-UV PES and XPES spectrum of H_2 , N_2 and O_2 , HCl , HBr and HI - Application of Koopman's theorem- Spin Orbit coupling. Photo electron spectrum of Xe , Kr , Ar - Spin spin coupling O_2 , NO molecules- Auger lines- Binding energy- Oxidation state correlation. **12 hrs**
- UNIT IV:** Nuclear Magnetic Resonance: Origin- chemical shift, dependence on field- spin spin coupling- coupling constant- factors influencing coupling constant - geminal coupling and vicinal coupling- Long range coupling- Dependence of coupling constant on 's' electron density-Decoupling and off Resonance- NOE effect- factors contributing to it. Two dimension NMR spectroscopy-COSY, NOESY, DEPT. **12 hrs**
- UNIT V:** Electron spin resonance:Introduction-Electron Zeeman effect, Hyperfine interaction, structural information, EPR of Benzyl anion, pyrazyl anion, BH_3 , PH_4 , F_2 - Nephelauxetic effect- Factors affecting EPR spectrum - Low symmetry fields- Anisotropic 'g' and hyperfine coupling constants, and Zero field splitting. Mossbauer Spectroscopy Origin-Isomer shift-correlation with S electron density, Quadrupolar splitting- ^{57}Fe (bonding and structure of Fe^{2+} Fe^{3+} compounds) and Instrumentation Structure -Low & high spin-iron carbonyls-prussiates- Turnbull's blue-structure **12 hrs**

RECOMMENDED TEXT BOOKS:

1. Structural Methods in Inorganic Chemistry- EAV Ebsworth, D.Will Rankin, S.Cradock, Blackwell scientific publ (1987)
2. Physical methods in Inorganic Chemistry- Drago R.S.-Reinhold -1965
3. Infrared spectra of Inorganic and coordination compounds – Nakamoto K., 2ndedn Wiley 1970
4. Basic principles of spectroscopy R.Chang, McGraw Hill, New york (1971)
5. Fundamental of molecular spectroscopy, C.N.Banwell, McGraw Hill Newyork 1966
6. Organic spectroscopy, William Kemp 3rd edn, 2001

7. W.H.Freeman & Co, 1991 Spectroscopic methods in organic Chemistry by Silverstein Bassler
8. Instrumental method of analysis by H.Willard, W.Merrit, J Dean. 6th edn Van Nostrand 1981
9. Introduction to mass spectrometry : instrumentation, applications and strategies for data interpretation by J. Throck Watson, O. David Sparkman, John wiley & sons, 2007, 4thediton
10. Basic one- and two-dimensional NMR spectroscopy by Horst Friebolin, Weinheim, Wiley-VCH, 2011, 5th edition
11. Introduction to spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, Belmont, CA:Brooks/Cole, Cengage learning, 2009,4th edition.

REFERENCE BOOKS:

1. Inorganic Electronic spectroscopy-A.B.P.Lever-Elsevier, Amsterdam (1984)
2. Physical methods in advanced inorganic Chemistry, H.A.O Hill and P.Day, John Wiley (1968)
3. Coordination Chemistry Experimental methods, J.K.Burger butterworths (1973)

PERIODICALS:

1. Resonance- Journal of science education
2. Applied Spectroscopy
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. *www.virtlab.com*
2. *http://nptel.ac.in*
3. *MATLAB*
4. *mooc.org*
5. *http://swayam.gov.in*
6. *http://search.ebscohost.com*
7. *www.spectro.com*

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	2	2
CO 2	3	3	3	2	2
CO 3	3	3	3	2	3
CO 4	3	3	3	2	1
CO 5	3	3	3	2	2
Average	3	3	3	2	2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1

No Correlation - 0

Teaching Methodology: Lecture (Chalk & Talk) , Seminar, Flipped Learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER - II

Common to I M.A /M.Sc/M.Com

Title of the course: Non Major Elective 1-Cosmetology

Teaching hours: 15 x 4 = 60

Credits: 3

Course Code: 6P21/2E/COS

L T P 3 1 0

Objectives:

1. To improve one's own personal appearance and develop self confidence.
2. To develop skill in cosmetology.
3. To acquire knowledge about chemicals in cosmetics
4. To learn the facial procedures in cosmetology
5. To understand the usage of cosmetics and Quality control of cosmetics.

COURSE OUTCOME

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

CO No.	CO Statement
CO 1	Develop positive attitude and a sense of personal integrity, practice proper grooming, skin care, massage, facial and make-up purposes
CO 2	Gain knowledge and practical skills on usage of face creams, lotions, bleaching, manicure, pedicure and waxing
CO 3	Learn skills in preparation and applications of face powder, nail care and importance of essential oils
CO 4	Learn knowledge on hair caring techniques and shampooing
CO 5	Acquire skill on hair removing techniques, cosmetic hazards and quality control

COURSE CONTENT

- UNIT I: Personality development:** Self analysis, grooming, professional behavior, personality development. Skin care-theory of massage, facials, facial manipulate one, skin treatment, Infect control for esthetics. Make-up- purpose and types, corrective make-up, optical illusion. **12 hrs**
- UNIT II: Face creams :** Types of face creams-cold, vanishing, cleaning and bleaching creams-preparation and application. Hand lotions and creams-simple method of preparation. **Bleaching:** Bleach, facial, facial massage- Herbal and synthetic applications, manicure, pedicure, waxing, **12 hrs**
- UNIT III: Powders:** Face powders, constituents in talcum powders-preparation and application. **Nail care:** Nail preparation-nail lacquer, nail enamels and nail bleach. **Oils:** Importance of Essential oils: Rose oil, almond oil, Eucalyptus oil, sandal wood oil in cosmetic industries. **12 hrs**
- UNIT IV: Hair caring :** Hair oils and hair creams, hair conditioning, hair cut, hair style,. hair

colouring, hair dye. **Shampoos and shampooing:** Types of shampoos, liquid, emulsion, paste or powder, ingredients. **12 hrs**

UNIT V: Hair removing techniques: temporary removal of hair- depilation process and epilation process-permanent removal of hair. . Hazards of cosmetics and quality control of cosmetics. **12 hrs**

RECOMMENDED BOOKS:

1. Reagents/Prentice Hall -Text book of Cosmetology by Mary Healy Eastern Economy Edition.
2. The complete book of beauty care - Aruna Anand

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	1	1	2	3
CO 2	3	3	1	2	3
CO 3	3	1	3	2	3
CO 4	3	3	1	3	3
CO 5	3	3	1	3	3
Average	3	2.2	1.4	2.4	3

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture(Chalk & Talk), Seminar

SEMESTERS I & II

Title of the Course: Core 7: Practical 1 - Organic Chemistry

(Qualitative and Quantitative Analysis)

Teaching hours: 30 x 4 = 120

Credits:4

Course Code: 6P21/2C/PR1

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Acquire skill and expertise in the separation of Organic mixtures , purification and identification of components
CO 2	Design single and multistage synthesis of complex organic compounds and execute them in the laboratory
CO 3	Apply skill in spectroscopic interpretation to elucidate structure of organic compounds

I. Spectral Interpretation of Organic Compounds. UV, IR, PMR and Mass Spectra of 15 Compounds.

1. 1,3,5-Trimethylbenzene
2. Pinacolone
3. Propyl amine
4. p-Methoxybenzyl alcohol
5. Benzyl bromide
6. Phenyl acetone
7. 2-Methoxyethyl acetate
8. Acetone
9. Isopropyl alcohol
10. Acetaldehyde diacetate
11. 2-N, N-Dimethylamino ethanol
12. Pyridine
13. 4-Picoline
14. 1, 3 dibromo-1, 1-dichloropropene
15. Cinnamaldehyde

II Qualitative Analysis

Qualitative analysis of an organic mixture containing two components - Separation, identification and preparation of derivatives. Determination of melting point/Boiling of the purified components and melting point of the derivatives.

III Quantitative Analysis

1. Estimation of Aniline.
2. Estimation of Phenol.
3. Estimation of Glucose.
4. Estimation of Ketone.
5. *Saponification value of an oil.
6. *Iodine value of an oil.

*IV Two stage preparations

1. Preparation of para bromo Acetanilide from Aniline.
2. Preparation of Benzanilide from Benzophenone.
3. Preparation of m-nitro Benzoic acid from Methyl Benzoate.
4. Preparation of symmetrical tri-Bromo Benzene from Aniline

*V Extraction of natural products

Purification and spectroscopic identification by UV-visible and FTIR.

1. Isolation of Citric acid from lemon.
2. Isolation of Caffeine from tea leaves.
3. Isolation of Lactose from milk.

*For internal assessment only.

*Note: Characterization by UV & IR spectra for the preparation

REFERENCE BOOKS:

1. Brian.S.Fumiss, Antony J.Hannaford, PeterW.G. Smith, AustmR.Tatchell, Vogel's , A Text-book of Practical Organic Chemistry, 5th edition, longmann Scientific and Technical,1989.
2. Ralph L.Shriner., The systematic identification of organic compounds,8th edition Hoboken,NJ:J.Wiley,2004
3. John Leonard, Garry Procter, Advanced Practical Organic Chemistry, CRC press, 2013.

WEBSITE LINKS:

1. <https://youtu.be/WYaUeFjLMFk>
2. <https://youtu.be/WkawbF-yHME>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	2
CO 2	3	3	3	3	2
CO 3	3	3	3	2	2
Average	3	3	3	2.6	2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Hands on Practical training & Demonstration, Discussion on the first principles

END SEMESTER PRACTICAL EXAMINATION

I M.Sc CHEMISTRY SEMESTERS I & II

QUESTION BANK

Title of the Course: Core 7 Practical 1- Organic Chemistry - (Qualitative & Quantitative analysis)

Course Code: 6P21/2C/PR1

Max: 60 marks

Total marks: 100 (40 CA+60 End semester)

Time: 6 hrs

1. Analyze the given spectra with the data given and identify the compound.
2. Analyze systematically the given organic mixture and report the nature of the two components after pilot separation.

Analyze the two components separately and report the following.

- a. Aromatic/aliphatic
- b. Presence/absence of elements nitrogen, sulphur and halogens.
- c. Saturated/unsaturated.
- d. Functional group
- e. Melting point or Boiling point of separated components
- f. Melting points of the derivatives

Exhibit the color reactions and the derivatives.

3. Estimate the amount of aniline present in the whole of the given solution. You are provided with an approximately decinormal solution of sodium thiosulphate.
4. Estimate the amount of phenol present in the whole of the given solution. You are provided with an approximately decinormal solution of sodium thiosulphate.
5. Estimate the amount of glucose present in the whole of the given solution. You are provided with an approximately decinormal solution of potassium permanganate.
6. Estimate the amount of ethyl methyl ketone present in the whole of the given solution. You are provided with an approximately decinormal solution of sodium thiosulphate.

Scheme of valuation

Total Marks 100- (CA 40 and End Semester 60)

Systematic analysis	-	20 marks
Estimation	-	20 marks
Spectral Interpretation	-	10 marks
Record	-	5 marks
Viva voce	-	5 marks
Total	-	60 marks

1. Systematic analysis

- 20 marks (Pilot separation -4 marks + Components 16 marks)

Analysis: (8 marks for component I and 8 marks for component II)

1. Aromatic/Aliphatic	-	1 mark
2. Saturation/Unsaturation	-	1 mark
3. Elemental detection	-	2 marks
4. Functional group	-	2 marks
5. Derivative	-	1 mark
6. Derivative melting point	-	1 mark
Total	-	8x2=16 marks

2. Estimation

- 20 marks

up to 2%	-	20
2.1- 3%	-	15
3.1- 4%	-	10
> 4%	-	5

SEMESTERS I & II

Title of the Course: Core: 8 -Practical 2 - Inorganic Chemistry (Qualitative & Quantitative Analysis)

Teaching hours: 30 x 4 = 120 Hrs

Credits: 4

Course Code: 6P21/2C/PR2

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Analyze qualitatively a mixture containing two rare and two common cations
CO 2	Estimate quantitatively the binary mixtures of metallic ions by volumetric and gravimetric methods, Calorimetric estimation of ions (Fe, Ni, Mn and Cu).
CO 3	Develop skills to analyze some common alloys and ores.
CO4	Acquire skills to prepare inorganic complexes and characterization by IR and UV-VIS absorption studies

I Qualitative Analysis of a mixture containing two rare and two common cations.

Rare ions W, Se, Te, Mo, Ce, Ti, Zr, V, Be and Li Th*, U*

Common ions Pb, Cu, Bi, Cd, Al, Zn, Co, Ni, Mn, Ba, Ca, Sr, & Mg

II Quantitative Analysis of mixtures

- Mixture containing Cu & Ni Copper Volumetrically and Nickel gravimetrically
- Mixture containing Cu & Zn Copper Volumetrically and Zinc gravimetrically
- Mixture containing Fe & Zn Iron Volumetrically and Zinc volumetrically
- Calorimetric Analysis-Spectrophotometric methods-Estimation of Fe, Ni, Mn & Cu

III *Analysis of Alloys and Ores

- Analysis of Dolomite, Pyrolusite
- Analysis of Brass

* Only for internal assessment

IV *Preparations

- Bis acetylacetonato copper (II)- Characterisation by IR, UV-VIS absorption studies in CHCl₃.

ii. Hexammine nickel (II) chloride-Study of electronic spectrum to calculate 10 Dq & Racah parameter.

iii. Tris thiourea copper (I) sulphate.

Note- * For Internal Assessment only

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	2
CO 2	2	2	2	2	2
CO 3	2	2	2	2	2
CO 4	2	2	2	2	2
Average	2.2	2.2	2.2	2.2	2

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Hands on practical training& Demonstration

End Semester Practical Examination
I M.Sc Chemistry SEMESTERS I & II
Question Bank

Title of the Course: Core 8- Practical 2 - Inorganic Chemistry (Qualitative & Quantitative Analysis)

Max Marks: 60
Time: 6hrs

Course Code: 6P21/2C/PR2

1. Analyze the given mixture systematically and report two common and two rare cations.
2. Estimate the amount of copper volumetrically and nickel gravimetrically, present in the whole of the given solution.
- or
3. Estimate the amount of copper volumetrically and zinc gravimetrically, present in the whole of the given solution.
- or
4. Estimate the amount of iron volumetrically and zinc also volumetrically, present in the whole of the given solution.
5. Estimate the amount of metal ions Cu /Ni /Mn /Fe colorimetrically

SCHEME OF VALUATION

Total Marks 100 (CA - 40 marks and End semester - 60 marks)

Qualitative Analysis 5 x 4 (20 marks)

Quantitative Analysis 2 x 10 (20 marks) (Gravimetric 10 marks + Volumetric 10 marks) or Calorimetric Analysis (20 marks)

Viva	10 marks
Record	10 marks

Total marks	60 marks

Volumetric / Gravimetric Estimation

ERROR UPTO 2 %	10 marks
2.1-3	8 marks
3.1-4	6 marks
>4	5 marks

SEMESTER - III

Course Code	Course title	L	T	P	Hours/ Week	Credits	TOTAL HOURS	Exam Hours	Marks		
									CA	SE	Total
6P21/3C/OC3	Core 9 - Organic Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3C/IC3	Core 10 - Inorganic Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3C/PC3	Core 11- Physical Chemistry - III	3	1	0	4	4	60	3	40	60	100
6P21/3E3/PHC	Major Elective 3- PhotoChemistry	3	1	0	4	3	60	3	40	60	100
6P21/3E/FDP	Non Major Elective -2 Fibre Fabrics , Dyeing and Printing of Textiles	3	1	0	4	3	60	3	40	60	100
6P21/3S/AAT	**Self- Study Paper for Advanced learners- Advanced analytical Tools for micro and nano structural analysis OR **Self- Study Paper for Advanced learners- BioInorganic and Supramolecular Chemistry					2					100
6P21/3S/BIS						2					100
6P21/4C/PR3	*Core Practical III - Physical Chemistry				4		120		40	60	100
	*Core - Project				4	-	-	-	40	60	100
6P21/3S/LSS	Soft Skill 3- Laboratory Safety Skills	2	0	0	2	2	30	2		50	50
6P21/3I/INT	Internship					2					
Total					30	22					

L = Lecture hours, T = Tutorial hours, P = Practical hours, CA = Continuous Assessment marks, SE = End semester Marks

*Practical Examinations are conducted once in a Academic year ie at the end of II & IV Semester

**Self-Study Paper for Advanced Learners

SEMESTER - III

Title of the Course: Core 9 -Organic Chemistry-III

Teaching hours: 15 x 4 = 60

Credits: 4

Course Code: 6P21/3C/OC3

L T P 3 1 0

Objectives:

1. To study the structure, properties and synthesis of natural products like alkaloids proteins, flavonoids, steroids, and terpenoids
2. To study the structure and role of nucleic acids
3. To introduce the basics of supra molecular chemistry
4. To study the synthesis and properties of heterocyclic compounds like Pyrazole, Oxazole and Thiazole and its derivatives
5. To study the Biosynthesis of Nucleotides.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Describe nomenclature , synthesis and properties of heterocyclic compounds
CO 2	Elucidate the structure of alkaloids , apply the principles of peptide synthesis to synthesize a tripeptide ,understand the different levels of structure of proteins and its properties
CO 3	Describe the preparation , properties of flavonoids, anthocyanidins and compare the UV- Visible spectrum of flavonoids
CO 4	Study the structure and synthesis of vitaminA, carotenes& cholesterol and methods of interconversion of cholesterol to hormones .
CO 5	Discuss the structure of DNA & RNA , its properties. Synthesis and application of supramolecules. , biosynthesis of cholesterol and supra molecules.

COURSE OUTLINE:

UNIT I: Heterocyclic Compounds: Nomenclature, synthesis and properties of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, benzimidazole, benzoxazole, benzthiazole. **12 hrs**

UNIT II: Alkaloids and Proteins: Total synthesis of quinine, morphine reserpine. (No Structural elucidation). Peptides and their synthesis-(Synthesis of any tripeptide using glycine,alanine, lysine, cystine, glutamic acid and argenine). Solid Phase Peptide synthesis-Merrified synthesis, Determination of primary structure of a protein, secondary tertiary and quaternary structure of proteins **12 hrs**

UNIT III: Flavanoids-Synthesis of the following (synthesis of parent compounds and simple hydroxy and methoxy substituted derivatives only) and products obtained on fusion with KOH or boiling with ethanoic KOH or Ba(OH)₂

- Flavones- Flavone, Chrysin, Apigenin and Luteolin
- Flavonols- Flavonol, Quercetin
- Isoflavones- Isoflavone, Daidzein
- Cyanidin Chloride and Cyanin Chloride
- Delphinidin Chloride and Delphin Chloride
- Malvidin Chloride and Malvin chloride and
- Hirsutidin Chloride and Hirsutin Chloride
- Distinction of Flavonoids by using characteristic colour reactions and absorption spectra (UV and visible)
- Relationship between Quercetin and Cyanidin Chloride

12 hrs

UNIT IV: Terpenoids: Synthesis of Vitamin A (Reformatsky and Wittig reaction methods only) and carotenes- biological functions. Steroids- Elucidation of structure of Cholesterol and Oestrone. Conversions of Cholesterol to Progesterone, Testosterone and Oestrone

12 hrs

UNIT V: Bio-organic Chemistry: Structure and role of (genetic code) DNA and RNA. Structure, name and representation of Nucleotides and Nucleosides (Structural Elucidation not necessary). Structures of products of hydrolysis of DNA and RNA- Action of dilute acid and alkali. Replication and protein synthesis. Nucleotide monophosphate (NMP), diphosphate (NDP) and triphosphate (NTP). ATP as currency of energy. Bio Synthesis of Nucleotides (No chemical synthesis)-DeNovo and salvage synthesis and synthesis of pyrimidine and purine derivatives-Adenine, Guanine, Cytosine, Uracil and Thymine (Chemical synthesis only). Biosynthesis of cholesterol. Supramolecules-General methods of synthesis and application of supramolecules.

12 hrs

RECOMMENDED TEXT BOOKS:

1. Organic Chemistry- Volume I and II, L.L.Finar, 5th Edition, ELBS publication
2. Organic Chemistry of natural products by Gurdeep Chatwal Volume I and II
3. Chemistry of organic natural products by Agarwal, Vol I, Geol Publishing House
4. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co. 2008.

REFERENCE BOOKS:

1. Stanley H.Pine, Organic Chemistry, 4th edn Mac Graw Hill
2. Outlines of Biochemistry V Edition by Eric E. Conn, Paul. R. Stumpf, George Bruening and Roy H. Dole, John Wiley and Sons.
3. Principles of Biochemistry General aspects by L. Smith, Robert L. Hill I. Robert Lehman, Robert J. Let Rowitz, Philip Handlar and Abraham white. McGraw Hill Int. (7th Edition)

4. Biochemistry by Lubert Stryer, WH. Freeman and Co., New York
5. S. William Pelletier Alkaloids: Chemical and Biological Perspectives; Volume VIII, Edition -I Springer-Verlag New York
6. An Introduction to the Alkaloids. Von G. A. Swan. Blackwell Scientific Publications, Oxford-Edinburgh 1968. Volume 80, issue 15
7. Introduction to Chemistry of Heterocyclic compounds by R.M.Acheson, interscience publishers
8. Heterocyclic Chemistry by T.L.Gilhrst, Longman Scientific and Technical (1991)
9. Heterocyclic Chemistry by Raj Bansal, Wiley Eastern Ltd.Jonathan W. Steed, Jerry. L. Atwood, Supramolecular Chemistry, John Wiley & Sons, 2002

PERIODICALS:

1. Journal of Organic Chemistry
2. Indian Journal of Chemistry B
3. Current Science
4. Organic Letters
5. Tetrahedron Letters

WEBSITES & e-LEARNING SOURCES

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	2	3	3	2
CO 2	3	3	2	3	2
CO 3	3	3	3	2	2
CO 4	3	2	3	2	2
CO 5	3	3	2	2	3
Average	3	2.6	2.6	2.4	2.2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Seminar,

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER - III

Title of the course: Core -10 Inorganic Chemistry-III

Teaching hours: 15 x 4 = 60

Credits: 4

Course Code: 6P21/3C/IC3

LTP 3 1 0

Objectives:

1. To focus on Electro analytical chemistry as applied to metal complexes
2. To study in detail the Analytical separation techniques
3. To create awareness to carry out qualitative and quantitative estimation of ions using modern instrumentation techniques
4. To focus on macrocyclic ligand systems with special emphasis on bioinorganic chemistry
5. To introduce research mind in the field of coordination chemistry

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain and apply the knowledge in working of various techniques such as polarography, coulometry, voltammetry to simple systems
CO 2	Demonstrate an understanding of various chromatographic techniques and its applications, principle and applications of Flame Photometry, Thermogravimetric analysis, ability to select and use appropriate analytical separation techniques.
CO 3	Outline and discuss the structure and properties of various macrocyclic ligands.
CO 4	Explain various proteins associated in transportation of ions, solutes inside and between the cells.
CO 5	Solve problems related to plant growth, crop production and natural resource management

COURSE OUTLINE

UNIT I: Analytical Chemistry: Polarography- Theory apparatus, DME, Diffusion, Kinetic and catalytic current, Voltage curve for reversible and irreversible systems, Qualitative and Quantitative-inorganic analysis. Amperometric titration-theory, apparatus, types of titrations and two indicator electrodes. Application-cyclic voltametry- theory, application to inorganic systems. Complexometric titrations- Types of EDTA titrations, direct and back titrations, replacement titrations. Masking and demasking agents. Coulometry: Coulometry-Theory, Apparatus, Different types, Applications -Coulometric titrations. **12 hrs**

- UNIT II:** Analytical techniques: Chromatography- Gas liquid chromatography, principles, retention volumes, instrumentation, carrier gas column, preparation, stationary phases, detectors, thermal conductivity, flame ionization, electron capture application of GLC. High performance in liquid chromatography, scope column efficiency, instrumentation- ion pumping system, column packing detectors- applications. Flame Photometry-Atomic absorption spectroscopy, theory, atomizers, flames atomically and electron thermal, instrumentation, spectral and chemical interferences applications. Thermal methods of analysis. Thermogravimetric analysis, differential thermal analysis, thermometric analysis. **12 hrs**
- UNIT III:** Macrocyclic ligands: Schiff's bases, Crown ethers, Cryptates, tetraaza ligands, catenanes and spherands. Macrocyclic effect- template effect. **12 hrs**
- UNIT IV:** Transport proteins & Oxygen carriers-haemoglobin, myoglobin, hemerythrin-cytochromes, carboxy peptidase, carbonic anhydrase, biochemistry of Zn, Iron, Sulphur proteins. **12 hrs**
- UNIT V:** Photosynthesis- Chlorophyll, discussion on photosystems I & II. Vitamin B₁₂- Structure of corrin ring, function of vitamin. Role of Na, K, Ca, Mg & Cu. Fixation of nitrogen and nitrogenase enzymes. **12 hrs**

RECOMMENDED TEXT BOOKS:

1. K.F.Purcell and J.C.Kotz, Inorganic chemistry, SWB Saunders Co (1977)
2. J.E.Huheey, Harper and Collins, Inorganic chemistry, Ny IV edn
3. J.R.Chatwal, A.K.Bhogi, Bioinorganic chemistry, Himalaya publishers.
4. D.F.Shriver and P.W.Atkins, Inorganic chemistry, oxford university press, 3rd edn 1999
5. D.Banerjee, Coordination chemistry, Tata McGraw Hill 1993
6. P.K.Bhattacharya, Metal ions in Bio chemistry, Narosa publishing House (2005)
7. D.A.Skoog, Principles of instrumental methods of analysis, Saunders collage publication III Edition (1985)
8. Wilard Merrit, Dean and Settle, Instrumental methods of analysis, CBS Publ, VI Edition (1986)
9. Vogel, Text book of qualitative inorganic analysis, ELBS III Edition, (1976) and IV Edition (1985)
10. D.O.Halls, K.K.Rao, Photosynthesis, Vedn Cambridge University press
11. Bertini, H.B.Gray, S.J.Lippard, Bio inorganic chemistry, J.S.Valentine (ed) - University Science Books, mill valley (1994)
12. Bioinorganic enzymology, Chem.Rev.7(1996)

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	2	2
CO 2	3	3	3	2	2
CO 3	3	2	3	3	3
CO 4	3	3	2	2	2
CO 5	2	2	2	2	2
Average	2.8	2.6	2.6	2.2	2.2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk) , Seminar, Flipped learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER - III

Title of the course: Core 11-Physical Chemistry-III

Teaching hours: 15 x 4 = 60

Credits: 4

Course code: 6P21/3C/PC3

LTP 3 1 0

Objectives:

1. To understand the theory of relationship between microscopic and macroscopic phenomena.
2. To study the thermodynamic properties of single molecules and their interaction with their bulk counterparts.
3. To study the thermodynamic aspects and applications.
4. To study the Phase equilibria of three component systems.
5. To study the thermodynamic aspects of Phase Transitions

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain knowledge on basic concepts of ensembles, statistical probabilities in the filling of atomic and molecular energy levels, partition functions and their derivation.
CO 2	Acquire skill to relate molecular partition functions with thermodynamic and kinetic parameters and derive mathematical expressions
CO 3	Analyze and apply concepts of partition function to heat capacities of solids and gases, black body radiation
CO 4	Gain in-depth knowledge of concepts of phase equilibria and interpret the phase diagrams of simple and complex (ternary) systems
CO 5	Correlate the thermodynamic aspects of compound formation, phase transition and salting.

COURSE OUTLINE

UNIT I: Statistical Thermodynamics I: Objectives of statistical thermodynamics-concept 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. Modes of contribution to energy, Maxwell's law of distribution of molecular speeds, graphical representation, experimental verification, derivation of expressions for average, most probable and root mean square velocity. **12 hrs**

- UNIT II: Statistical Thermodynamics II:** Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions- calculation of equilibrium constants from partition functions, isotope exchange and dissociation of diatomic molecules. **12 hrs**
- UNIT III: Statistical Thermodynamics III:** Applications of partition function to heat capacities of ideal gases-heat capacity of solids-Einstein and Debye theory of heat capacity of solids. Thermodynamics of black body radiation, Wein Stefan- Boltzmann law. **12 hrs**
- UNIT IV: Phase Equilibria I:** Phase, Component, Degrees of freedom determination, Roozeboom plots, Scheme of triangular plot-method of parallel lines, direct method & Lever rule method, Systems of three liquid components exhibiting partial miscibility - Formation of one pair, two pairs and three pairs (eg. Chloroform- Acetic acid -water) of partial miscibility, effect of temperature. Ternary systems of two solid components and a liquid - Crystallization of pure components only. **12 hrs**
- UNIT V: Phase Equilibria II:** Formation of binary compounds - hydrates and double salt- Congruently saturating (eg. Diphenylamine-benzophenone system), and incongruently saturating, formation of ternary compounds, solid solutions, solid solutions with partial miscibility, Salting out phenomena, Thermodynamic aspects of phase transitions, dependence of stability-temperature and pressure. The Ehrenferst classification of phase transition-I order II order phase transitions and lambda transitions. **12 hrs**

RECOMMENDED TEXT BOOKS:

1. Chemical Thermodynamics: Classical, Statistical and Irreversible, Rajaram and Kuriakose, 2013 edition, Pearson Publications
2. M.C.Gupta- Statistical Thermodynamics, Wiley Eastern, New Delhi 1990
3. A Textbook of Physical Chemistry - K.L.Kapoor, Vol. 3, 2012 edition.

REFERENCE BOOKS:

1. Statistical Thermodynamics, M.Dole, Prentice Hall, Newyork, 1954.
2. Statistical Thermodynamics, N.O.Smith B.J.Clelland Chapman and Hall, London 1973 Elementary
3. Statistical Thermodynamics, a problems approach, Plenum Press, Newyork, 1980
4. The Phase rule and its applications: Alex Fixdlay, 3rd editions Longman Green and Co.
5. Physical Chemistry by Peter Atkins and Jullio de Paula, 10th edition Oxford press
6. Physical Chemistry, I.N. Levine, 5th Ed., Tata McGraw Hill Pub. Co. Ltd., New Delhi.

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. *Mooc.org*
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>
7. *e - book Introductory Physical Chemistry by David Ronis, McGill University 2011*

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	2	1
CO 2	3	3	3	2	1
CO 3	3	3	2	2	1
CO 4	3	3	3	1	3
CO 5	3	3	3	2	1
Average	3	3	2.6	1.8	1.4

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Power Point presentation, Seminar, Flipped Learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER-III

Title of the Course: Major Elective 3 – Photochemistry

Teaching hours: 15 x 4=60

Credits: 3

Course Code: 6P21/3E3/PHC

L T P 3 1 0

Objectives:

1. To study the principles of photochemistry,
2. To study the fate of excited molecules - Jablonski diagram
3. To study the different types of Photochemical reactions and its applications.
4. To study the photochemistry of ketones and a few rearrangement reactions
5. To study the principles of orbital symmetry for different organic reactions

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain advanced knowledge on interaction of radiation with matter, principles of photochemistry and its applications.
CO 2	Demonstrate the difference between radiative and non-radiative transitions with the help of Jablonski diagram
CO 3	Explain kinetics of different types of photochemical reactions , acquire knowledge on photogalvanic cells ,photoelectrochemical cells and solar energy conversion
CO 4	Compare direct photolysis and sensitized photolysis reactions. Discuss the mechanism of photochemical reactions of ketones and photochemical rearrangement reactions
CO 5	Predict and formulate the outcomes of pericyclic reactions in terms of orbital interactions and/or the Woodward-Hoffmann Rules & FMO approach and explain fluxional behavior in molecules

COURSE OUTLINE:

UNIT I: Fundamentals of Photochemistry: Interaction of electromagnetic radiation with matter. Absorption and emission of radiation, sources of irradiation and filters, internal and external methods of irradiation. Photochemical excitation-types of excitation, quantum yields and chemical actinometry. **12 hrs**

UNIT II: Fate of the excited molecules: excited state life time, singlet and triplet states- allowed and forbidden transitions. Jablonski diagram- radiative and non-radiative processes- internal conversion, inter system crossing, fluorescence and phosphorescence. Energy transfer process- sensitization, excimer and exciplex, Stern Volmer analysis - static and dynamic quenching. **12 hrs**

UNIT III: Applications of Photochemistry: Photophysical processes and kinetics of photochemical reactions-photoredox reactions, photo substitution reactions, photosensitized reactions- photo isomerisation reactions. Photo voltaic and photo

galvanic cells, photo electrochemical cells, photo assisted electrolysis of water. Aspects of solar energy conversions. TIST (Twisted Intramolecular Charge Transfer) **12 hrs**

UNIT IV: Organic Photochemistry: Examples for direct photolysis - singlet excited state and sensitized photolysis involving the triplet state. Introduction of a quencher to a photochemical reaction proceeding from the triplet state. Photochemistry of *alkene-cis-trans* isomerization. Study of photochemistry of ketones - Photoreduction of Ketones, Intramolecular reactions- Norrish Type-I and Norrish Type-II cleavages, saturated acyclic and cyclic carbonyl compounds. Rearrangements of 1,4-dienes-di-pi-methane rearrangement. Re-arrangement of α - β - unsaturated ketones-oxa-di-pi- methane rearrangement. Intermolecular cycloaddition reaction of ketone-Paterno- Buchi reaction, Barton reaction, Photofragmentation reactions-Hofmann-Lofler-Freytag reaction, Photo-Fries reaction. **12 hrs**

UNIT V: Pericyclic reactions: classification-orbital symmetry- Woodward Hoffmann rule- conrotation and disrotation. Electrocyclic reactions- thermal and photochemical cyclisations and ring openings- stereochemistry of electrocyclic reactions- FMO method and correlation diagram for butadiene-cyclobutene and 1,3,5- hexatriene- 1,3 cyclohexadiene systems. Cycloadditions- thermal and photochemical- stereochemistry- FMO method and correlation diagrams of [2+2] and [4+2] cycloadditions and 1,3-dipolar addition Sigmatropic rearrangements- stereochemistry-thermal and photochemical- FMO method. Cope re-arrangement- stereochemistry-oxy-cope rearrangement, degenerate Cope re-arrangement- fluxional molecules-homotropylidene, barbarlone, bullvalene, Claisen rearrangement. **12 hrs**

RECOMMENDED BOOKS:

1. K.K.Rohatgi Mukherjee- Fundamentals of Photo Chemistry, Wiley Eastern Limited
2. Advanced Organic chemistry by J.March 5thedn Wiley Interscience 2001
3. Pericyclic reactions by Jagdamba Singh, Newage International publishers, 4th edition

REFERENCE BOOKS:

1. N.J.Turro- Modern Molecular Photo chemistry, Menio Park, California 1991
2. J.G.Calvert & J.N.Pitts- Photo Chemistry, Wiley, London 1996
3. R.P.Wayne- Photo Chemistry, Butterworths, 3rd edn London Oxford univ press, 2000
4. B.R.Cundall & A.Gilbert- Photo chemistry, Thomas Nelson, London, 1970
5. Molecular Reaction and Photo chemistry by Charles H.Depuy and Orvill E.L.Chapman, Prentice Hall of Indian Ltd., New Delhi, 1988
6. Organic Photo chemistry by Coxon and Halton 2ndedn Cambridge univ press, 1974
7. Pericyclic reactions- A Mechanistic Study by S.M. Mukherjee, Mac Millan, 1979
8. Organic Photochemistry and Pericyclic reactions by Dr. Shankar Raman, 2005

PERIODICALS:

1. Journal of Organic Chemistry
2. Indian Journal of Chemistry B
3. Current Science
4. Organic Letters
5. Tetrahedron Letters
6. Journal of Indian chemical education
7. Journal of American chemical society

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	1	2	2	2
CO 2	2	2	2	1	1
CO 3	3	2	2	2	3
CO 4	3	3	1	2	3
CO 5	3	3	1	2	3
Average	2.8	2.2	1.6	1.8	2.4

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1
No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk, LCD), Flipped Learning - E Content, Videos, Problem solving, Seminar, Quiz, Flipped learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER- III

Common to II M.A/M.Sc/M.Com

Title of the Course: Non Major Elective 2 -Fibres, Fabrics, Dyeing and Printing of Textiles

Teaching hours: 15 x 4 = 60

Credits: 3

Course Code: 6P21/3E/FDP

L T P 3 1 0

Objectives:

1. To impart basic knowledge in Textile production from fibre to fabric stage
2. To stress the importance of Natural fibres and their applications
3. To give the students a theoretical knowledge in dyeing and printing
4. To gain knowledge on weaving & spinning methods
5. To inculcate entrepreneur skills in the students

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Classify fibres and demonstrate textile production from fibre to fabric
CO 2	Discuss the types of fibres and explain the cultivation and processing methods
CO 3	Demonstrate knowledge on weaving and spinning methods of fibre
CO 4	Comprehend classification of dyes, methods and principles of dyeing of silk, cotton, wool and nylon
CO 5	Understand various methods of printing and its applications

COURSE OUTLINE

UNIT I: Textile fibres: Classification - Based on the origin of fibres- natural fibres of vegetable and animal origin- Manmade fibres- semi synthetic and synthetic fibres. Classification based on the thermal properties -thermoplastic and nonthermoplastic fibres. Man made fibres,Semi synthetic fibres-characteristics and uses of cellulose acetate and cellulose triacetate - Arnel. Synthetic fibres-characteristics and uses of polyamides- Nylon 6,6 and Nylon 6-finishing nylon fabrics **12 hrs**

UNIT II: Natural fibres of vegetable origin: Cotton-types-cultivation-transformation of raw cotton to yarn- Byproducts- mercerization, slack mercerization, Ammoniating-yarn twist, yarn count-composition and characteristics. Natural fibres of animal origin. Silk-silk producing countries, sericulture-cultivation of cocoons composition. Transformation of cocoons to silk yarn, degumming, weighting, spun silk, pure dye silk and wild silk, composition and characteristics. **12 hrs**

UNIT III: Fabrics: Classification of yarn Fabric construction-Spinning methods-Melt, dry and we spinning. Weaving-basic weaves-plain, variations of plain-basket, rib-twill and satin weaves. Identification of weaves and designs. **12 hrs**

UNIT IV: Dyes: Classification - main types of synthetic dyes and their characteristics - basic methods and principles of dyeing. Dyeing cotton fabrics with Naphtha, direct, sulphur and vegetable dyes-wool-silk-nylon. **12 hrs**

UNIT V: Basic methods of printing and its applications: direct printing, discharge printing and resist printing. Printing Block, roller, screen, transfer, Batik, resist, kalamkari, Tie and dye. **12 hrs**

RECOMMENDED BOOKS:

1. Textile - Fabric to Fabrics - Dr. Bernad P. Lorbman.

PERIODICALS:

16. Resonance- Journal of science education
17. Span
18. Indian academy of sciences-proceedings- Chemical Sciences
19. Current Science
20. Journal of Indian chemical education
21. Journal of American chemical society
22. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	2	3	3	3
CO 2	3	2	3	3	3
CO 3	3	2	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Average	3	2.4	3	3	3

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk & Talk)

ESE Question Paper Pattern PG - Non Major Elective

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	B - 8/10 x 5 Marks	250	40	100
K3, K4	C - 6/9 x 10 Marks	500	60	

SEMESTER-III

Self-Study Paper for Advanced Learners

Title of the Course: Advanced Analytical Tools

Course Code: 6P21/3S/AAT

Credits: 2

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Understand the phenomena of ORD and CD
CO 2	Apply Microstructure determination
CO 3	Utilize the analytical techniques for surface determination

COURSE OUTLINE

UNIT I: Spectroscopy of Organic compounds: Optical rotatory dispersion and circular dichroism: Phenomena of ORD and CD. Classification of ORD and CD Curves; Cotton effect curves and their application to stereochemical problems; the Octant rule and its application to alicyclic ketones.

UNIT II: Application of X-ray in the microstructure determination: X-ray fluorescence spectroscopy, Quantitative analysis of XRF spectra, XRF analysis of environmental and biological samples on subcellular level, metal pollutants and essential elements in plant tissues. X-ray absorption near edge structure (XANES), also known as near edge X-ray absorption fine structure.

UNIT III: Surface analysis of micro and nano structures : Quantitative analysis of surface-BET and BJH pore analysis- Determination of surface area, pore volume, pore size distribution, advance Microscopy- , Scanning Transmission Electron Microscopy (STEM), Scanning Probe Microscopy(SPM), Applications to micro and nano structures

REFERENCE BOOKS:

1. R. J. Hamers and D. F. Padowitz, "Methods of Tunneling Spectroscopy with the STM," from Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications, 2nd ed., Ed. by D. A. Bonnell, New York: Wiley-VCH, Inc., 2001.
2. E. Meyer, H.J. Hug,R. Bennewitz, Scanning Probe Microscopy - The Lab on a Tip, Springer-Verlag, Berlin, 2003.

3. Nanoscience: Nanotechnologies and Nanophysics, C. Dupas, Ph. Houdy, M. Lahmani (Eds), SpringerVerlag, Berlin 2007.
4. Williams and Carter, *Transmission Electron Microscopy*, Springer, 2009.
5. Egerton, *Electron energy Loss Spectroscopy in the Electron Microscope*, Plenum, 1996.
6. Goodhew, P.J. and Humphreys, F.J., *Electron Microscopy and Analysis*, 2nd Edition, Taylor & Francis, 1988.
7. Goldstein et al, *Scanning Electron Microscopy and X-ray Microanalysis*, Springer, 2003.
8. Bunker, G. "Introduction to XAF S: a practical guide to X-ray absorption fine structure spectroscopy", 2010, Cambridge University Press.
9. Koningsberger, D.C. "X-ray absorption spectroscopy: principles, applications, techniques of EXAF S , SEXAF S and XANE S ", 1987, Wiley.
10. Teo, B. K. "EXAF S: basic principles and data analysis", 1986, Springer-Verlag.
11. Duke, P. J. " Synchrotron radiation: production and properties", 2000, Oxford University Press.
12. Edgar Bright Wilson, P. C. Cross, J. C. Decius, *Molecular Vibrations: The Theory of Infrared and Raman Vibrational Spectra*, Dover Publications, 1994.
13. Wilson R.G., F.A. Stevie and C.W. Magee, *Secondary Ion Mass Spectrometry*, (Wiley, New York, 1989).
14. Vickerman J.C, in *Secondary Ion Mass Spectrometry: Principles and Applications*, eds. J.C. Vickerman, et al.(Oxford, New York, 1989a,b,c,d,e) p. 1, p. 9, p. 35, p. 149, p. 272.

SEMESTER III

Self -Study Paper for Advanced Learners

Title of the Course: BioInorganic and Supramolecular Chemistry

Course Code: 6P21/3S/BIS

Credits: 2

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Understand the role of metal ions in biology
CO 2	Gain advanced knowledge in clinical Analysis
CO 3	Acquire indepth knowledge in Supramolecular chemistry

COURSE OUTLINE

- UNIT I: Role of metal ion in biological system:** Na⁺ - K⁺ pump - Mechanism, Transport and storage of dioxygen: Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper
- UNIT- II: Clinical analysis:** Composition of blood- collection and preservation of samples. Clinical analysis: Serum electrolytes, blood glucose, blood urea, uric acid, albumin and globulin. Evaluation of Organ Function Tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin.
- UNIT-III: Supramolecular chemistry:** Molecules and Supramolecules, Supermolecules, Large Molecules Classification, Nomenclature, Thermodynamic and Kinetic selectivity, Supramolecular interactions, Supramolecular host design. Macrocyclic versus acyclic hosts, chelate Macrocyclic and macrobicyclic hosts, High dilution synthesis, Template synthesis. Molecular recognition: Receptors, design and synthesis of co-receptors and Multiple recognition, hydrogen bonds, strong, weak and very weak H-bonds, Utilisation of H-bonds to create supramolecular structures.

REFERENCE BOOKS:

1. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books
2. Inorganic Biochemistry Vol. I and II. Ed. G.L.Eichhorn (Editor), Elsevier, 1973
3. G.D. Christian, Analytical Chemistry, J. Willey John Wiley & Sons, 6th edition, 2007
4. Alka L. Gupta, Analytical Chemistry, Pragati Edn., 2006.
5. H. Kaur, Instrumental Methods and Chemical Analysis, Pragati Edn., 2006.
6. J.H. Kennedy, Analytical Chemistry Principles and Techniques, W.B. Saunders, India edition, 2011
7. D.A. Skoog, Principles of Instrumental Analysis, Saunders College Pub. Co, III Edn., 1985.
8. G.W. Ewing, Instrumental Methods of Chemical Analysis, McGraw Hill Pub. 1975.
9. Supramolecular Chemistry; Concepts and Perspectives, J.M. Lehn, VCH, Wiley india, 2014
10. P. S. Kalsi, J. P. Kalsi, Ashu Chaudhary, Bioorganic, Bioinorganic and Supramolecular Chemistry, fourth edition, New age international publishers, 2020
11. Textbook of Medical Biochemistry by MN Chatterjee and Rana Shinde, Jaypee Brothers, eighth edition, 2012

SEMESTER- III

Title of the course: Soft Skill 3- Laboratory Safety Skills

Teaching hours: 15 x 2=30

Credits: 2

Course Code: 6P21/3S/LSS

L T P 2 0 0

Objectives:

1. To study the safety measures involved in handling of chemicals.
2. To develop an awareness in first aid techniques.
3. To create an awareness in waste and fume disposals.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Apply safety precautions skills to store and handle various hazardous chemicals to avoid accidents in the laboratory.
CO 2	Use of first aid techniques and preparing for emergencies and incident reporting procedures.
CO 3	Learn waste treatment techniques, disposal management and utilize appropriate methods to dispose the waste properly. .

COURSE OUTLINE

- UNIT I:** Storage and handling of chemicals: carcinogenic chemicals, glove box, handling of ethers, toxic and poisonous chemicals, safe limits of vapour concentrations. Precautions for avoiding accidents, laboratory safety measures **10 hrs**
- UNIT II:** First aid techniques: Eye injuries, fire and burns, cuts, electric shock, poisoning treatment for specific poisoning, conc.H₂SO₄, carcinogens, hazards in laboratory, LPG-composition, characteristics, handling -gas leakage detector -fire extinguisher-principle and usage. **10 hrs**
- UNIT III:** Waste disposal- Fume disposals, Fume cupboard. Nuclear reactor management- low level wastes, intermediate level wastes, high level wastes, ultimate disposal. Radioactive waste disposal: Radioactive wastes: sources of radioactive wastes- classification of wastes-treatment techniques for solid, liquid and gaseous effluents-permissible limits for disposal of wastes. Disposal of radioactive wastes: General method of disposal-management of radioactive in medical, industrial and research establishment. **10 hrs**

RECOMMENDED BOOKS:

1. Elements of Analytical Chemistry, Gopalan R, Rangarajan K, Subramanian P.S. 3rd edition, 2013
2. Source book on Atomic Energy, Samuel Glasstone, 3rd edition, 1979.
3. Handbook On Chemicals And Hazardous Waste Management And Handling In India, Centre

For Environmental Law, Education, Research And Advocacy National Law School Of India University,2019.

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	2
CO 2	2	3	2	3	2
CO 3	3	3	1	3	2
Average	2.7	3	2	3	2

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture Chalk & Talk), Seminar, Flipped Learning

ESE Question Paper Pattern PG - Soft Skill

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	A - 10/12 x 5 Marks	250	50	100

SEMESTER-III

Title of the Course: Internship

Teaching hours: 15 X 5 = 75

Credits: 2

Course Code: 6P21/3I/INT

L T P 0 0 0

Objective

- To gain practical experience by working in a professional environment related to the subject
- To utilize the principles of different branches of chemistry to solve real-world problems and ability to work as a team
- To develop the skill to write the internship report

COURSE OUTCOMES:

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

CO No.	CO Statement
CO 1	Integrate knowledge and skills learnt at the college in Industry / Research Institution
CO2	Develop ability to work in a team for scientific investigation and reporting as projects are of interdisciplinary type
CO 3	Demonstrate satisfactory ability to communicate rationally , logically, concisely, clearly and effectively the nature of the work done during internship programme

Mapping : Course Outcomes with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3
CO2	2	3	3	3	3
CO3	2	3	3	3	3
Average	2	3	3	3	3

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1

No Correlation - 0

Teaching Methodology: Hands on practical training

SEMESTER - IV												
Course Code	Course title	L	T	P	Hours /Week	Credits	TOTAL HOURS	Exam Hours	Marks			
									CA	SE	Total	
6P21/4C/OC4	Core 12 - Organic Chemistry - IV	4	1	0	5	4	75	3	40	60	100	
6P21/4C/IC4	Core 13 - Inorganic Chemistry - IV	4	1	0	5	4	75	3	40	60	100	
6P21/4E4/ECC	Major Elective 4 - Electrochemistry and Computational Chemistry	4	1	0	5	4	75	3	40	60	100	
6P21/4E5/POC	Major Elective 5 - Polymer Chemistry	3	1	0	4	3	60	3	40	60	100	
6P21/4C/PR3	*Core 14 Practical III - Physical Chemistry				4	4	120	6	40	60	100	
6P21/4C/PRO	*Core 15 - Project	-	-	-	5	4	-	-	40	60	100	
6P21/4S/SRP	Soft Skill 4- Scientific Research and Presentation Skills	2	0	0	2	2	30	2		50	50	
		Total			30	25						
		Total Credits				93						

L = Lecture hours, T = Tutorial hours, P = Practical hours

CA = Continuous Assessment marks, SE = End semester Marks

*Practical Examinations are conducted once in a Academic year ie at the end of II & IV Semester

SEMESTER-IV

Title of the Course: Core 12-Organic Chemistry-IV

Teaching hours: 15 x 5 = 75

Credits: 4

Course Code: 6P21/4C/OC4

L T P 4 1 0

Objectives:

1. To study the concept of Retro synthesis and synthetic strategies of organic compounds
2. To study the principles of Green chemistry and Sonochemistry
3. To study the various important Name reactions in organic chemistry
4. To study the Synthesis of some important target molecules
5. To study the aromaticity of annulenes and the different type of aromatic compounds.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain in depth knowledge in the formation of C-C bonds , protection and deprotection of functional groups and use of select reagents in organic synthesis
CO 2	Compile and demonstrate knowledge on Retrosynthesis and various terminologies , Retro synthesis of simple molecules - alcohols, alkenes and di carbonyl compounds , formation of C-C bond using different coupling reactions
CO 3	Outline the principles of green chemistry and explain the various protocols in organic synthesis . Design synthesis of target molecules from given organic starting materials at reasonably high-yields
CO 4	Explain the mechanism , stereochemical aspects and applications of various named reactions.
CO 5	Discuss the aromaticity of annulenes and study the structure and properties of different types of aromatic /antiaromatic compounds

COURSE OUTLINE

UNIT I: Modern Synthetic Methodology-1: Formation of C-C bond using alkylation and acylation of enamines, enolates, active methylene compounds and organo metallic compounds- RMgX, R₂LiCu, RLi, Pd complexes , O-alkylation vs C-alkylation. Protection and deprotection of functional groups (R-OH, R-CHO, RCOR, R-NH₂ and R-COOH). Uses of the following reagents in organic synthesis: Trimethyl silyl chloride, 1,3-dithiane (umpolung), (DIBAL). 9-BBN, tributyl tin hydride, LDA **15 hrs**

UNIT II: Modern Synthetic Methodology-2: An introduction to Retrosynthesis- Disconnections Synthon- Nucleophilic, electrophilic and neutral and their Synthetic equivalent, Target molecule, Functional group inter-conversion Retro synthesis of simple molecules - alcohols, alkenes, carbonyl compounds, 1,2, 1,3,1,4,1,5 & 1,6 dicarbonyl compounds. Formation of C-C bond using Pd & Ni catalyst - Heck reaction, Sonogashira coupling,

Suzuki coupling, Kumada coupling, Negishi coupling and Stille coupling **15 hrs**

UNIT III: Modern Synthetic Methodology-3: Synthesis of Target molecules- 5-hexenoic acid, bicycloheptan [4,1,0]-2-one, Cubane, Longifolene, Brufen, trans-9- methyl-1-decalone. Green chemistry- need for green chemistry, twelve principles, choice of starting materials, choice of reagents, choice of catalysts-bio catalysts and polymer supported catalysts (examples), choice of solvents Sonochemistry- principles, instrumentation applications in esterification, hydrolysis, substitution and addition reactions. Microwave assisted synthesis-Principles, instrumentation, limitations and precautions. Applications-deprotection of esters, C- and N- alkylation. **15 hrs**

UNIT IV: Synthetic Applications of Name reactions: Mannich, Darzen, Reformatsky reaction, Wittig reaction- Stabilised and non- stabilized ylides, Diels Alder reaction, 1,3-Dipolar addition, Hydroboration, Michael addition, Robinson annulation reaction (Stereochemical aspects to be studied wherever applicable). Typical formylation reactions-Gattermann-Koch, Gattermann, Vilsmeier Haack and Riemer-Tiemann and Houben Hoesch reactions, Chichibabin reaction and Zeigler alkylation, Shapiro reaction. **15 hrs**

UNIT V: Aromaticity- Benzenoid, heterocyclic and non-benzenoid compounds, diatropic behaviour in NMR. Huckel's rule- aromatic systems with pi electron numbers other than six-anulene. Non aromatic (cyclooctatetraene) and anti-aromatic systems- paratropic behaviour in NMR (cyclobutadiene) systems with more than 10 pi electrons- annulene-(18)-annulene. (Synthesis of all these compounds is not needed). Homoaromatic compounds **15 hrs**

RECOMMENDED BOOKS:

1. Guide book to Organic Synthesis by Raymond K. Mackie and David M. Smith, ELBS Publication
2. W. Carruther, Jain Coldham, Modern Methods of organic synthesis, 4th Edition

REFERENCE BOOKS:

1. Advanced Organic Chemistry by Francis A. Carey and Richard J. Sundberg - Part A and Part B
2. Advanced Organic Chemistry by Pine, Cram and Hammond.
3. Organic synthesis by R.E. Ireland, Prentice Hall of India, Geol Publishing House.
4. Principles of Organic synthesis by R.O.C. Norman, Champan and Hall, NY, 1980
5. Stuart Warren, Work book for organic synthesis, The Disconnection Approach John Wiley & Sons (Asia) Pvt. Ltd.

PERIODICALS:

1. Journal of Organic Chemistry
2. Indian Journal of Chemistry B

3. Current Science
4. Organic Letters
5. Tetrahedron Letters

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping : Course Outcomes with programme specific outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	2	2
CO 2	3	3	3	2	3
CO 3	3	3	2	3	2
CO 4	3	2	3	2	2
CO 5	3	2	3	2	3
Average	3	2.6	2.6	2.2	2.4

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Problem solving, Seminar, Flipped learning

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER –IV

Title of the course: Core 13-Inorganic Chemistry-IV

Teaching hours: 15 x 5=75
Course Code: 6P21/4C/IC4

Credits: 4
L T P 4 1 0

Objectives:

1. To study some important aspects of organometallic chemistry
2. To study the industrial applications of organometallic catalyst
3. To introduce the principles and applications of Nuclear chemistry
4. To obtain knowledge about fission, fusion reactions and nuclear reactors
5. To introduce environmental problems and possible treatment Procedures

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain knowledge on the structure, bonding and reactions of metallocenes and study of fluxional behavior
CO 2	Learn the mechanism of select reactions - hydrogenation, oxoprocess , Wacker process , Zeigler Natta polymerization catalysed by organometallic compounds and its applications
CO 3	Understand the basics of nuclear chemistry , detection and determination of radioactivity of elements
CO 4	Explain nuclear fission and fusion reactions & study the applications of nuclear chemistry in diverse fields.
CO 5	Demonstrate methods of water treatment in detail, ambient air quality standard, use of analytical methods to identify the toxins present in the environment and methods to eradicate.

COURSE OUTLINE

UNIT I: Organo metallic chemistry: Carbon donors: alkyls and aryls: metallation, bonding in carbonyls and nitrosyls: Chain and cyclic donors. Olefin acetylene and allyl systems: synthesis: structure and bonding: metallocenes- ferrocene, Reactions: Fluxional molecules-study of allyl, allene, cyclooctatetraene, and cyclopentadienyl p^1 & p^5 systems-NMR evidence. Organometallic compounds of Litium. Beryllium, Magnesium, Boron and Alluminium **15 hrs**

UNIT II: Catalysis: hydrogenation of olefins (Wilkinsons catalyst) hydroformylation of olefins using cobalt or rhodium catalysts (oxo process), oxidation of olefins to aldehydes and ketones. (Wacker process): polymerization (zeigler natta catalyst): stereospecificity - mechanisms, cyclo oligomerization of acetylene using nickel catalyst (Reppe's catalyst): polymer bound catalysts. **15 hrs**

UNIT III: Nuclear Chemistry I: Nuclear properties- Nuclear spin and moments, origin of nuclear forces, salient features of liquid drop and the shell models of nucleus. Models of radioactive decay:-Orbital electron capture nuclear isomerism, internal conversion, detection and determination of activity by cloud chamber, nuclear emulsion, bubble chamber, G.M. Scintillation and Cherenkov counters. **15 hrs**

UNIT IV: Nuclear Chemistry II: Nuclear reaction: Types, reaction, cross section, Q-value, threshold energy, compound nucleus theory, high energy nuclear reaction, nuclear fission and fusion reactions as energy sources, direct reaction, photonuclear and thermonuclear reaction, Nuclear reactors- Breeder technology, reactions involved. Application relating to nuclear chemistry: Neutron activation analysis, radiopharmacology, autoradiography, isotope dilution analysis. **15 hrs**

UNIT V: Environmental Chemistry: Water treatment-primary, secondary and tertiary stages in detail BOD-COD Ambient air quality standard- Allowed level, permissible limit, oxides of nitrogen, photochemical smog. Toxic chemicals in environment LD Toxicity of Hg, Pb, Cu. Analytical methods in environmental toxins- soil pollution-contamination of soil due to excess use of fertilizers-pH of the soil- Remedy. **15 hrs**

RECOMMENDED TEXT BOOKS:

1. Text book of environmental chemistry by O.D.Thiyagi and M.Mehta, Anmol Publications Pvt Ltd (1996).
2. H.J.Arniker, Nuclear Chemistry, Wiley Eastern Co., II edition Wiley-Blackwell (1987)
3. F.A.Cotton and G.Wilkinson, Advanced inorganic chemistry, John wiley & sons (2007) VI edition
4. K.F.Purcell and J.C.Kotz, Inorganic Chemistry, SWB saunders co., (1980)

REFERENCE BOOKS:

1. Comprehensive environmental studies by Dr.J.P.Sharma Laxmi Publications (2006)
2. Environmental chemistry by B.K. Sharma, 13 edition, Krishna's Educational Publications (2014)
3. Source books on atomic energy, S.Glasstone, Van Nostr and Co, Krieger Pub Co; 3 edition (1979)
4. Nuclear and Radiochemistry, G.Friedlander, J.W.Kenedy, J.M.Miller, John Wiley and sons (1981).
5. Principles of Organometallic chemistry, P. Powell, Springer Netherlands (1988)
6. Reaction Mechanism of Inorganics and organometallic Systems, R.B.Jordan, Oxford University Press (2007).
7. Organometallic chemistry, R.C.Mehrotra, A.Singh, New Age International Publishers Ltd.-New Delhi (2000)

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. mooc.org
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping: Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	2
CO 2	2	2	2	2	3
CO 3	2	2	2	2	2
CO 4	2	2	2	2	2
CO 5	2	2	2	2	1
Average	2.2	2.2	2.2	2.2	2

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Flipped Learning , Seminar

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER - IV

Title of the course: Major Elective 4 - Electrochemistry and Computational Chemistry

Teaching hours: 15 x 5 = 75

Credits: 4

Course Code: 6P21/4E4/ECC

LTP 4 1 0

Objectives:

1. To understand the concepts, principles and theories of ionic and electronic interactions in solutions
2. To explore thermodynamic models of electrode-electrolyte interface
3. To study the working and applications of electro chemical systems - Cells and Batteries
4. To derive the kinetics and the parameters affecting them
5. To understand first principles atomic structure using computational methods.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Familiarize the concepts of ion-ion interactions, ion solvent interactions, calculations of ionic activity and ionic strength
CO 2	Analyze and compare various thermodynamic models of electrode-electrolyte interface and derive mathematical equations.
CO 3	Derive mathematical expressions for electrocapillary, single and multi-step electrochemicals and exchange current density.
CO 4	Correlate the causes and control of corrosion using Pourbaix and Evans diagrams and to design primary and secondary batteries, dry cells with maximum energy efficiency
CO 5	Apply the tools of computational chemistry, calculate atomic and molecular energy levels using software tools and molecular modelling techniques.

COURSE OUTLINE

UNIT I: Electrochemistry I: Ionics: Ions in solutions, true and potential electrolytes, ion - solvent, ion - ion interactions, ionic strength- concept and calculations, Debye Huckel theory of strong electrolytes, Poisson equation, Poisson- Boltzman equation, activity coefficient and mean ionic activity coefficient of electrolytes, Debye Huckel limiting law - Derivation, verification and its extensions, Debye Huckel Onsager equation- derivation and verification. **15 hrs**

UNIT II: Electrochemistry II: Electrochemicals: Electrode-electrolyte interface, adsorption at electrified interface-electrical double layer, Structure of double layers, Influence of double layers in charge transfer processes. Helmholtz-Perrin, Guoy Chapman and Stern models of electrical double layers. Influence of Double layers in charge transfer processes. Thermodynamic derivation of electrified interfaces- Lipmann capillary equation- electro capillary phenomenon, Polarizable and Non Polarizable electrodes. Electrokinetic phenomenon- explanation of this phenomenon with the concept of forces and flux- Onsager reciprocity. **15 hrs**

UNIT III: Electrochemistry III: Electrode reactions- Butler Volmer equation for one step electron transfer reactions. Limiting cases- Tafel and Nernst equation. Significance of equilibrium exchange current density and symmetry factor, transfer co-efficient. Electrochemical (inorganic and organic) reactions of technological interest (one example each). **15 hrs**

UNIT IV: Electrochemistry IV: Mechanism of electrode reactions-polarizations and over potential -Corrosion and passivation of metals- Pourbaix (Iron and Lead systems only) and Evans diagrams. Prevention from corrosion-anodic and cathodic protection, corrosion inhibitors. Electrochemical energy systems -primary and secondary batteries- dry cells, lead acid storage batteries, Solid state batteries - Working, Charging and Recharging principle- Lithium and Sodium ion battery in telecommunication gadgets, advantages- Fuel cells- Classification, Working principle and applications, Electrodeposition - principles and applications.

15 hrs

UNIT V: Computational Chemistry: A brief outline of molecular mechanics, semi-empirical approximations, *ab initio* methods, basis sets and Z-matrix; Gaussian, Slater type. Density Function Theory- overview- Kohn Hohenberg and Kohn Sham equation (no derivation) Basic concepts of molecular dynamics and simulations. **15 hrs**

RECOMMENDED TEXT BOOKS:

1. S. Glasstone- Introduction to Electrochemistry, Affiliated East West press, New Delhi
2. D. R.Crow-Principles and Applications of Electrochemistry, Chapman and Hall.
3. Frank Jensen, Introduction to computational chemistry, 2nd edition, John Wiley & Sons Ltd. (2007)
4. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, John Wiley & Sons, 2002.
5. D. Young, Computational Chemistry: A practical Guide for applying Techniques to Real World Problems, Wiley Interscience, 2001.
6. A.R.Leach, Molecular Modelling: Principles and Applications, Pearson Education, 2001.
7. J. B. Foresman, A. Frisch, Exploring Chemistry with Electronic Structure Methods. Gaussian Inc., 1996.
8. M. P. Allen and D. J. Tildesley, Computer Simulations of Liquids, Oxford, 1987
9. Gileadi, Physical Electrochemistry, Fundamental, Techniques and Applications, Wiley-VCH, 2011
10. J.Bard and L. R Faulkner Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley, 2001
11. H. Rieger, Electrochemistry, 2nd Edition, Springer 1994
12. Computational Chemistry, Introduction to the Theory and Applications of Molecular and Quantum Mechanics, Lewars, Errol G. 2011

REFERENCE BOOKS:

1. J.O.M.Bockris and A.K.N.Reddy-Electrochemistry-Vol I & II, Plenum, Newyork 1977

2. P.Delhay - Electrode Kinetics and structure of double layer interscience, New york, 1965
3. J.Robbins-Ion in solution-an introduction to electro chemistry, Clarendon press, Oxford (1972)
4. C.M.A.Brett and A.M.O.Brett -Electrochemistry principles, methods and applications, OUP,Oxford, 1993.
5. P.H.Rieger-Electrochemistry,Chapman and Hall, Newyork (1994)
6. R.L.De Koch and H.B.Gray - Chemical structures and Bonding, Benjamin/Cummings, Menlo Park, California.

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education

WEBSITES & e-LEARNING SOURCES:

1. *www.virtlab.com*
2. *http://nptel.ac.in*
3. *MATLAB*
4. *Mooc.org*
5. *http://swayam.gov.in*
6. *http://search.ebscohost.com*
7. *http://ccl.osc.edu/ccl.cca.html*
8. *http://www.chem.swin.esu.au/chem_ref.html*
9. *http://www.colby.edu/chemistry/PChem/Lecture1.html*
10. *http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/electrode.html#c3*

Computational chemistry software

1. SPARTAN
2. *http://www.wavefun.com*
3. GAUSSIAN
4. *www.gaussian.com*
5. MOLPRO
6. *www.tc.bham.ac.uk/morpro*

Mapping: Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	3	1
CO 2	3	3	3	3	2
CO 3	3	3	3	2	1
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Average	3	3	2.8	2.8	2

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Power Point presentation, Sharing online interactive sessions and Videos in the classroom, Sharing web links

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTER- IV

Title of the course: Major Elective-5 Polymer Chemistry

Teaching hours: 15 x 4=60

Credits: 3

Course Code: 6P21/4E5/POC

L T P 3 1 0

Objectives:

1. To learn the theoretical concepts in polymer chemistry
2. To appreciate their significance and applications of polymers
3. To motivate the students to pursue research in polymer chemistry
4. To study the techniques for characterization of polymers
5. To study the mechanism of polymerization

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Explain various concepts and types of polymerisation and classify polymer structure
CO 2	Demonstrate and explain the mechanism and kinetics of polymerization reactions
CO 3	Explain the bond forces , mechanical Properties , degradation and electrical conductivity of polymers
CO 4	Analyse and characterize polymer by spectral methods
CO 5	Discuss various polymer processing methods and its applications

COURSE OUTLINE

UNIT I: Introductory Survey: Concept of Polymers, common terms used in Polymers- Classification of Polymers-natural and synthetic Polymers-condensation polymers, addition polymers, co-polymerization, polymerization of cyclic compounds- Inorganic Polymers-Techniques of polymerization- bulk polymerization-solution polymerization, suspension polymerization, emulsion polymerization, melt poly condensation-interfacial condensation-solid and gas phase polymerization and plasma polymerization. Polymer Structure-Co-polymers, Tacticity, Geometrical isomerism. **12 hrs**

UNIT II: Mechanism and Kinetics of Polymerisation: Step Growth Polymerisation or Polycondensation Chain Polymerisation- Radical polymerization Anionic polymerization, Cationic polymerization, coordination polymerization, with respect to Ziegler Natta catalyst, co-polymerization, composition of co-polymers-block and graft co-polymers,-ring opening-polymerisation. **12 hrs**

UNIT III: Structure and Properties: Primary and secondary bond forces in Polymers. Coherence energy-structure property relationship. Mechanical properties-Tensile strength, Compressive, Flexural strength, fatigue resistance and impact resistance Relationship between molecular weight and mechanical properties. Glass Transition Temperature Degradability-Degradation by a. Oxidative degradation b. Mechanical, c. Ultrasonic wave. d.Photo degradation bio degradation Chain flexibility. Electrical Conductivity. Flow properties of polymer melts and solutions.

12 hrs

UNIT IV: Polymer Analysis and Characterisation: Identification-Physical testing, IR, NMR, (spectral methods) Identification of typical plastic materials eg. ABS, Acrylics, polyfluorocarbons pvc..Other examples polystyrene, poly vinyl acetate, polyvinyl alcohol. Testing Thermal, electrical and chemical. Characterization - Molecular weight distribution in polymers. Determination of molecular weight, fractionation-gel permeation chromatography, number average molecular weight- osmometry. Weight average molecular weight light scattering measurements, ultracentrifugation, viscosity and DLS method.

12 hrs

UNIT V: Polymer Processing and Applications: Plastics-thermosetting and thermoplastics, Rubber-the composition of rubber latex- the processing of rubber Natural and Synthetic fibres criteria for fibre formation. Basic Processing Operations-Extrusion, Moulding, Calendering, Coating Membrane Application for Polymeric Materials. Biomedical Applications-Artificial Organs, Controlled Drug Delivery,Hemodialysis and Hemofiltration. Application in Electronics-Electrically conductive polymers, electronic shielding, encapsulation. Polymers in Photonics applications, Drag Reduction and Dendrimers.

12 hrs

RECOMMENDED TEXT BOOKS:

1. F.W.Billmeyer- Textbook of Polymer science, Wiley interscience
2. A.Rudin- The elements of Polymer Science and Engineering- An introductory text for engineers and chemists, Academic Press, Newyork
3. Polymer Science- V.R.Gowarikar, N.V.Viswanathan & Jayadev Sreedar
4. Principles of Polymer Science- P.Bhadur, N.V.Sastry, Warosa Publishing House
5. Introductory Polymer Chemistry-G.S .Mi shra

REFERENCE BOOKS:

1. C.E.H.Bawn- The chemistry of high polymers, Butterworth and Co., London
2. E.A.Collins, J.Bares and E.W.Billmeyer- Experiments in Polymer Science, Wiley Inter Science, New york
3. G.S.Krishenbaum-Polymer Science study guide, Gordon Breach Science Publishing, New york
4. G.Odien - Principles of Polymerisation, Mc Graw Hill book co, Newyork
5. P.H.Flory- Principles of Polymer Chemistry, Cornell Press, Ithaca
6. Polymer Science and Technology- Joel and Fried

7. Polymer Chemistry- An introduction, Malcolm P.Stevens.

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. *MATLAB*
4. *mooc.org*
5. <http://swayam.gov.in>
6. <http://search.ebscohost.com>

Mapping: Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Average	3	3	3	3	3

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (Chalk& Talk), Flipped learning , Seminar

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B - 5/8 x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

SEMESTERS III & IV

Title of the Course: Core 14-Practical III - Physical Chemistry

Teaching hours: 30 x 4 = 120

Credits: 4

Course Code: 6P21/4C/PR3

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Explain the principle of conductivity, potentiometry, kinetics and phase rule experiments.
CO 2	Determine the strength of unknown solutions by potentiometric and Conductometric methods.
CO 3	Determine the kinetics, thermodynamics and other factors influencing reactions.

I Kinetics: -

1. Study of the kinetics and determination of the Arrhenius parameters, activation energy E_a and frequency A factor graphically for the acid catalysed hydrolysis of methyl acetate.
2. Comparison of acid strengths of hydrochloric acid for hydrolysis of methyl acetate catalysed by acid
3. Determination of the rate constant and order of reaction for the reaction between potassium persulphate and potassium iodide
4. Study of the primary salt effect on the kinetics of ionic reactions - Bronsted Bjerrum relationship - for the reaction between Potassium Iodide and Potassium persulphate

II **Adsorption:-** Study of the adsorption of acetic acid or oxalic acid on charcoal and verification of Freundlich adsorption isotherm and determination of concentration of given acid.

III Conductivity:-

1. Determination of the equivalent conductance of a weak acid at different concentrations and determination of dissociation constant of the acid.
2. Study of the saponification of ethyl acetate and determination of the order of the reaction conductometrically
3. Comparison of the strengths of acetic acid and monochloro acetic acid by conductance method.
4. Determination of equivalent conductivity of strong electrolyte at infinite dilution and testing the validity of Onsager's theory as limiting law at high dilutions.

5. Conductometric titrations:-
 - b. Standardisation of sodium hydroxide using standard hydrochloric acid and determination of strengths of hydrochloric acid and acetic acid in a mixture.
 - c. Standardisation of Silver Nitrate using Standard KCl and determination of strengths of KCl and KI in the mixture.

IV Potentiometry:-

1. Determination of the strength and hence the dissociation constant of weak acid by potentiometric method.
2. Determination of the strengths of KCl & KI in the given mixture by titration against silver nitrate potentiometrically.
3. Determination of pH of three given buffer solutions by emf method using quinhydrone electrode and the influence of added alkali or acid on them, provided with a standard buffer solution.
4. Determination of the strength of HCl and CH₃COOH in the given mixture by titration against NaOH using quinhydrone electrode.
5. Determination of the strength of the given solution of Fe²⁺ by potentiometric titration against standard potassium dichromate.
6. Determination of the strength of the given solution of KI by potentiometric titration against standard potassium permanganate.

V Phase study:

Construction of a phase diagram for binary system.

- a. Simple Eutectic Naphthalene - Biphenyl

Naphthalene -p-dichlorobenzene

Naphthalene - diphenylamine

*b. With Compound formation Naphthalene - m-dinitrobenzene

*Determination of solubility product of a sparingly soluble salt Potentiometrically-
Chemical Cell method

*For Internal valuation only

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
Average	3	3	3	3	3

KEY : Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Hands on training and Demonstration

END SEMESTER PRACTICAL EXAMINATION

SEMESTERS III & IV

QUESTION BANK

Title of the Course: Core 14- Practical III - Physical Chemistry

Course Code: 6P21/4C/PR3

Time: 6hrs

Max.Marks: 60

1. Studies the kinetics of acid catalysed hydrolysis of methyl acetate and compare the given acid strengths.
2. Study the kinetics of acid catalysed hydrolysis of methyl acetate at three different temperatures differing by 10°C and hence evaluate the Arrhenius parameters E_a and A graphically. You are provided with 0.5 N HCl
3. Study the kinetics of reaction between 0.1 M KI and 0.05M $K_2S_2O_8$ aqueous solutions in the absence and presence of three different concentrations of KNO_3 - A, B, C and arrange the rate constants in the order of increasing ionic strength.
4. Determine the strength of the given acetic acid solution and verify Freundlich adsorption isotherm.
5. a. Determine the Λ_∞ value for the given strong electrolyte conductometrically. The cell constant for the cell is given.
b. Determine the strengths of the strong acid and weak acid present in the given mixture conductometrically
6. a. Determine the strength and hence the dissociation constant of the given weak acid by potentiometric method.
b. Determine the pH of three given buffer solutions A, B, C using D as standard by emf method using quinhydrone electrode and the influence of added alkali or acid on it.
7. a. Determine the strength of given solution of KI by potentiometric titration against standard potassium permanganate.
b. Determine the strength of the given solution of Fe^{2+} by potentiometric titration against standard potassium dichromate.
8. a. Determine the strength of the given silver nitrate solution by potentiometric titration against std. KCl.
b. Determine the strengths of KCl and KI in the given mixture by potentiometric titration against std. silver nitrate.
9. Construct the freezing point - percentage composition diagram for the system of two given solids A and B. Use the diagram to fix the composition of the unknown mixture of A and B.

SCHEME OF VALUATION

Total Marks 100 (CA-40 + End Semester -60)

Record	-	10
Viva voce	-	10
Manipulation	-	10
Skill	-	30
Total	-	60

1. Ester hydrolysis

$k_1 = 4 + 4$ [calculation + graph] $E_a = 3$ marks

$k_2 = 4 + 4$ [calculation + graph] $A = 3$ marks $k_3 = 4 + 4$ [calculation + graph]

Below a factor of 10 = Full marks

Upto a factor of 10 = Reduce 2 marks

Above a factor of 10 = Reduce 4 marks

2. $K_2 S_2 O_8$ & KI reaction

For each k value - 6 marks [3 + 3] [calculation + graph] 6 x 4 = 24 marks

Arranging the rate constants in increasing order - 6 marks

3. Adsorption

Verification of Adsorption isotherm by Graph - 10 marks Up

to 5% - 20 marks

Above 5- 10% % - 15 marks

>10% - 5 Marks

4. Conductometry

a) Determination of strength of the acid-15 marks

Verification and determination of the constants

Error	Marks
Upto 10 %	15
Above 10-15%	10
Above >15%	5

b) Determination of Λ^* for strong electrolyte conductometrically

Λ_{∞} of strong electrolyte = 15 marks

Upto 10% error = 15 marks

Above 10% to 15% = 10 marks

Above 15% = 5 marks

c) Determination of strength of weak acid - 7.5 marks

Determination of strength of strong acid - 7.5 marks

Error	Marks
Upto 5%	7.5
Above 5-10%	5
Above 10%	2

5. Potentiometry

1. Potentiometric Titration

Error	Marks	For mixtures
Upto 5%	15	7.5 + 7.5 marks each
Above 5-10%	10	5 + 5 marks each
Above 10-15%	6	3 + 3 marks each

a) Determination of strength of weak acid - 10 marks

Error	Marks
Upto 5 %	5
> 5-10 %	5
> 10 %	5

Determination of K_a of weak acid - 5 marks

Below a factor of 10 - 5 marks

A factor of 10 - 3 marks

Above a factor of 10 - 2 marks

b) Determination of pH of three buffer solutions: 5 x 3 = 15 marks

Determination of E_{cal} - 5 marks

Interpretation of results - 10 marks

8.	Phase Diagram	-	20 marks [8+4+4]
	Unknown composition	-	10 marks
	Phase diagram	-	8 marks
	Freezing point of components A and B	=	4 marks [2+2]
	Eutectic temperature	-	4 marks
	Eutectic composition	-	4 marks
	Total	-	30 marks

Eutectic temperature

Error	Marks
+/- 2°	4 marks
+/- 3°	2 marks
>3°	1 marks

Eutectic composition - 4 marks

Error	Marks
+/- 5%	4
6-10%	2
> 10%	1

Unknown composition

Error	Marks
+/- 5%	10
6-10%	8
> 10%	5

SEMESTER-IV

Title of the Course: Core 15 - Project

Teaching hours: 15 X 5 = 75

Credits: 4

Course Code: 6P21/4C/PRO

L T P 0 0 5

Course Objective

- To complete an independent research project, resulting in thesis submission, and research output in terms of publication / presentation in a conference
- To gain practical experience by working in a professional environment and utilize the principles of different branches of chemistry studied
- To develop all skill sets to face the challenges in the field of research

COURSE OUTCOMES

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

CO No.	CO Statement
CO1	Learn to do and compile literature survey , acquire in depth knowledge , identify problem formulate, plan and perform experiments to find apt solutions
CO2	Demonstrate research skills, professionalism through working interactions with supervisors, co-workers and people related to the organisations / institutions, collaboration and independent learning and prepare for lifelong learning and challenges ahead
CO3	Select skills to communicate effectively and present ideas clearly and coherently to defend their research work to a panel of experts in both written and oral format

Mapping : Course Outcomes with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	3	3	3	3	3
CO3	3	3	2	3	3
Average	3	3	2.6	2.7	3

**KEY: Strongly correlated -3 Moderately correlated -2 Weakly correlated -1
No Correlation -0**

SEMESTER IV

Title of the course: Soft Skills 4-Scientific Research and Presentation Skills

Teaching hours: 15 x 2= 30

Credits: 2

Course Code: 6P21/4S/SRP

L T P 2 0 0

Objective:

1. To develop the skills needed for analysis and presentation of research data
2. To create awareness towards research problem.
3. To introduce computational skills required for research.

COURSE OUTCOMES

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

CO No.	CO Statement
CO 1	Gain knowledge of scientific resources available for undertaking a quality research
CO 2	Learn the concept of formatting, statistical data analysis and ethical guidelines for research
CO 3	Acquire the skill to prepare a good quality manuscript adhering to ethics of publishing
CO 4	Apply the knowledge of computer programming- language of C and write programs for simple scientific calculations using it.
CO 5	Learn the skill of presenting the research work to public forums using modern software tools.

COURSE OUTLINE

UNIT I: Selection of research problems and writing- Project proposal-funding agencies-Survey of scientific literature-Primary and secondary sources. Impact factor and citation index. Thesis and Assignment writing. Conventions of writing-General format-page and chapter format-use of quotations and foot notes-preparation of tables and figures-referencing- appendices-revising, editing and evaluating the final material- proof reading -meanings and examples of commonly used abbreviations. Plagiarism, copy right and patent laws. **10 hrs**

UNIT II: Statistical treatment: Precision and Accuracy-Reliability-Determinate and random errors-Distribution of random errors-Normal distribution curve. Statistical treatment of finite samples-the student's T test and F test-criteria for rejection of an observation Q test. Significant figures and computational rules.Data plotting-Least square analysis-significance of correlation coefficient. Publication of research paper-manuscript preparation Referencing-endnote **10 hrs**

UNIT III: Computer and their application to Chemistry: Computer binary language, introduction-hardware, software-programming-C. Language-variables, constants, operators-input, output functions- control statements, loop, functions arrays and pointers. Programming to calculate pH of a solution, solubility product, standard deviation and correlation coefficient for a straight line. Microsoft Word, Excel, Power point presentation, Internet. **10 hrs**

RECOMMENDED TEXT BOOKS:

1. K.V.Raman, Computers in chemistry, Tata McGraw Hill, New Delhi 1993
2. Thesis and Assignment writing, J. Anderson, B.H. Durston and M.Poole, Wiley East Ltd (1970)
3. Ramesh Kumari Computers and their applications to chemistry: Narosa publications. **REFERENCES:**
 1. Advanced organic chemistry: Reactions, Mechanism and structure, J. March, McGraw - Hill International Student edition, 1977.
 2. Instrumental methods of chemical analysis (4th edition), G.W. Ewing, McGraw Hill International Student edition, 1975.
 3. Quantitative Analysis (3rd edition), R.A. Jr. and A.L. Underwood, Prentice - Hall of India Pvt. Ltd. (1977).
 4. Techniques of Organic Chemistry, Ed. A. Weissberger (series of volumes) Wiley -Inter sciences.
 5. Statistical Analysis Chemistry and Chemical Industry, C.A Bennett and N.L.Franklin, John Wiley (1954).
 6. Correlation Analysis in organic chemistry - An introduction to linear free energy relationships, J. Shorter, Olarendon Press. Oxford (1973) [Oxford chemistry series11].
 7. The way they learn Siendia Ulrich Tobiah- Pindole house Inc. U.S.A
 8. Tactist - Rosemary Napper and Trudy Newton, TA resources, U.K 2003.
 9. Hand book for Authors -Journal of the American Chemical Society Publications
 10. Chemical Publications-Their nature and uses.
 11. N.Gurumani, Scientific Thesis Writing and Paper Presentation, MJP Publisher,2019.

PERIODICALS:

1. Resonance- Journal of science education
2. Span
3. Indian academy of sciences-proceedings- Chemical Sciences
4. Current Science
5. Journal of Indian chemical education
6. Journal of American chemical society
7. Bulletin of material science

WEBSITES & e-LEARNING SOURCES:

1. www.virtlab.com
2. <http://nptel.ac.in>
3. **MATLAB**
4. Mooc.org
5. <http://swayam.gov.in>
6. <https://endnote.com/downloads>
7. <https://www.mendelev.com/download-desktop-new/>
8. <https://www.zotero.org/download/>
9. <https://www.latexbuch.de/install-latex-windows/>

Mapping : Course Outcomes with Programme Specific Outcomes

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	2
CO 3	3	3	3	3	2
CO 4	3	3	3	3	2
CO 5	3	3	3	3	3
Average	3	3	3	3	2.4

KEY: Strongly correlated - 3 Moderately correlated -2 Weakly correlated -1 No Correlation - 0

Teaching Methodology: Lecture (CHALK & TALK), Discussion on research publications in Journals, Seminar, Flipped Learning

ESE Question Paper Pattern PG - Soft Skill

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	A - 10/12 x 5 Marks	250	50	100

**ETHIRAJ COLLEGE FOR WOMEN [Autonomous]
CHENNAI- 08**

**END SEMESTER EXAMINATION
TEMPLATE OF THE QUESTION PAPER**

M.Sc Chemistry

Common to all Core theory and Major Elective papers

Title of the course

Max Marks:100

Paper Code

Time: 3hrs

Section A

Answer all the Questions

10Qx2=20 marks

Question Numbers 1 to 10,

Equal weightage to be given for all the 5 units in the syllabus.2 Questions from each unit.

Section B

Answer all the Questions

5Qx8=40 marks

Question numbers 11 to 15(5 Questions)

5 Questions to be given with an internal choice choosing one question from each unit ie 11a or 11b

Section-C

Answer any two questions

2Q X 20=40 marks

Question Numbers 16-19 (4 Questions)

4 questions to be given with a maximum of 4 subdivisions (a, b, c, d) giving equal weightage to all the five units in the syllabus.

Note: Equal weightage to be given to all the 5 units in the syllabus

Section A =10Q x 2 marks = 20 marks

Section B = 5Q x 8 marks = 40 marks

Section C = 2Q x 20 marks = 40 marks

Total = 100 marks

ESE Question Paper Pattern PG

Knowledge level	Section	Word Limit	Marks	Total
K3	A - 10 x 2 Marks	One or Two Sentences	20	100
K4, K5	B – 5(internal choice) x 8 Marks	250	40	
K4, K5	C - 2/4 x 20 Marks	500	40	

**ETHIRAJ COLLEGE FOR WOMEN [Autonomous]
CHENNAI- 8
END SEMESTER EXAMINATION
TEMPLATE OF THE QUESTION PAPER
Common to all Non Major Electives I& II year MA/M.Sc/M.Com**

Title of the Course: Cosmetology/Fibre, Fabrics, Dyeing and printing of Textiles

Course Code: 6P21/2E/COS// 6P21/3E/FDP

Max.Marks:100

Time: 3hrs

SECTION A

(8Q x 5 = 40)

ANSWER ANY EIGHT QUESTIONS

Question numbers 1-10.

8 Questions to be answered out of 10 Questions choosing two from each unit

SECTION-B

(6Qx10=60)

ANSWER ANY SIX QUESTIONS

Question numbers 11-19 (9 Questions).

6 Questions to be answered out of 9 Questions choosing not more than two questions from each unit.Each question can have a maximum of two subdivisions (a,b)

Note: Equal weightage must be given to all five units of the syllabus.

Section A -8Q x 5 marks= 40 marks.

Section B - 6Q x 10 marks=60 marks

ESE Question Paper Pattern PG- Non Major Elective

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	A - 8/10 x 5 Marks	250	40	100
K3, K4	B - 6/9 x 10 Marks	500	60	

**ETHIRAJ COLLEGE FOR WOMEN [Autonomous]
CHENNAI- 08
END SEMESTER EXAMINATION
TEMPLATE OF THE QUESTION PAPER**

Common to all Soft Skill Papers & Self-study papers

PG21/1S/PDT Soft skill 1 - Personality Enrichment for Women Soft Skill

6P21/3S/LSS 3- Laboratory Safety Skills

6P21/4S/SRP Soft Skill 4- Scientific Research and Presentation Skills

Time – 2 hrs

Max. Marks – 50

SECTION A

(10Q x 5 = 50 Marks)

10 Questions to be answered out of 12 Questions

ESE Question Paper Pattern PG - Soft Skill

Knowledge level	Section	Word Limit	Marks	Total
K3, K4	A - 10/12 x 5 Marks	250	50	100