CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

NATIONALLY ACCREDITED WITH "A" GRADE BY NAAC

ISO 9001:2015 Certified

TIRUCHIRAPPALLI

PG and RESEARCH DEPARTMENT OF CHEMISTRY

M.Sc. CHEMISTRY

SYLLABUS

2023 - 2024 and ONWARDS

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG and RESEARCH DEPARTMENT OF CHEMISTRY

VISION

- To progress into a centre of superiority in chemistry that will blend state-of-the-art practices in professional teaching in a communally enriching way, with the holistic progress of the students as its prime emphasis.

MISSION

- To produce graduates committed to integrity, professionalism and lifelong learning by widening their knowledge horizons in range and depth.
- To awaken the young minds and discover talents to achieve personal academic potential by creating an environment that promotes frequent interactions, independent thought, innovations, modern technologies and increased opportunities.
- To enhance the quality through basic and applied research frameworks, and encourage the students to take part in entrance and competitive examinations for higher studies and career.
- To enhance services to the community and build partnerships with the industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEOs	STATEMENTS
PEO1	**LEARNING ENVIRONMENT** To facilitate value-based holistic and comprehensive learning by integrating innovative learning practices to match the highest quality standards and train the students to be effective leaders in their chosen fields.
PEO2	**ACADEMIC EXCELLENCE** To provide a conducive environment to unleash their hidden talents and to nurture the spirit of critical thinking and encourage them to achieve their goal.
PEO3	**EMPLOYABILITY** To equip students with the required skills in order to adapt to the changing global scenario and gain access to versatile career opportunities in multidisciplinary domains.
PEO4	**PROFESSIONAL ETHICS AND SOCIAL RESPONSIBILITY** To develop a sense of social responsibility by formulating ethics and equity to transform students into committed professionals with a strong attitude towards the development of the nation.
PEO5	**GREEN SUSTAINABILITY** To understand the impact of professional solutions in societal and environmental contexts and demonstrate the knowledge for an overall sustainable development.

PROGRAMME OUTCOMES FOR M.Sc. Mathematics, M.Sc. Physics, M.Sc. Chemistry PROGRAMME

PO No.	Programme Outcome On completion of M.Sc. Programme, the students will be able to
PO1	**Problem analysis:** Provide opportunities to develop innovative design skills, including the ability to formulate problems, to think creatively, to synthesize information, and to communicate effectively.
PO2	**Scientific skills**: Create and apply advanced techniques and tools to solve the societal environmental issues.
PO3	**Environment and Sustainability:** Ascertain eco-friendly approach for sustainable development and inculcate scientific temper in the society.
PO4	**Ethics:** Imbibe ethical and social values aiming towards holistic development of learners.
PO5	**Lifelong learning:** Instill critical thinking, communicative knowledge which potentially leads to higher rate of employment and also for higher educational studies.

PROGRAMME SPECIFIC OUTCOMES FOR M.Sc. CHEMISTRY

PSO No.	Programme Specific Outcomes Students of M.Sc., Chemistry will be able to	POs Addressed
PSO1	Acquire knowledge in basic concepts, fundamental principles, and applications of chemical and scientific theories and their relevancies in the day-to-day life.	PO1 PO2
PSO2	Design experiments, analyze, synthesize and interpret data to provide solutions to different industrial problems by working in the pure, inter and multi-disciplinary areas of chemical sciences.	PO1 PO2 PO3
PSO3	Attain maneuver in diverse contexts with global Perspective.	PO3 PO4
PSO4	Gain a thorough Knowledge in the subject to be able to work in projects at different research as well as academic institutions.	PO1 PO2 PO5
PSO5	Afford Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR - NET examination.	PO1 PO2 PO3 PO4 PO5

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG AND RESEARCH DEPARTMENT OF CHEMISTRY

M.Sc. CHEMISTRY

(For the Candidates admitted from the Academic year 2023 - 2024 and onwards)

Semester	Course	Course Title	Course Code	Inst. Hrs. / week	Credits	Exam			Total
						Hrs.	Marks		
							Int.	Ext.	
I	Core Course– I (CC)	Organic Reaction Mechanism – I	23PCH1CC1	6	5	3	25	75	100
	Core Course – II (CC)	Structure and bonding in Inorganic compounds – I	23PCH1CC2	6	5	3	25	75	100
	Core Course –III (CC)	Molecular Spectroscopy	23PCH1CC3	6	5	3	25	75	100
	Core Practical - I (CP)	Organic Chemistry – I (P)	23PCH1CC1P	6	5	6	40	60	100
	Discipline Specific Elective Course-I (DSE)	A.Analytical Instrumentation Technique (P)	23PCH1DSE1AP	6	3	6	40	60	100
		B. Nanoscience and Nanotechnology (P)	23PCH1DSE1BP						
		C. Biochemistry (P)	23PCH1DSE1CP						
	Total			**30**	**23**				**500**
15 Days INTERNSHIP during Semester Holidays									
II	Core Course– IV (CC)	Physical Chemistry – I	23PCH2CC4	6	5	3	25	75	100
	Core Practical – II (CP)	Inorganic Chemistry – I (P)	23PCH2CC2P	6	5	6	40	60	100
	Core Choice Course– I (CCC)	A. Organic Reaction Mechanism – II	23PCH2CCC1A	6	4	3	25	75	100
		B. Chemistry of Natural Products	23PCH2CCC1B						
		C. Molecular Rearrangement	23PCH2CCC1C						
	Core Practical – III (CP)	Physical Chemistry– I (P)	23PCH2CC3P	6	5	6	40	60	100
	Discipline Specific Elective Course-II (DSE)	A. Green Chemistry	23PCH2DSE2A	6	3	3	25	75	100
		B. Forensic Chemistry	23PCH2DSE2B						
		C. Analytical Chemistry	23PCH2DSE2C						
	Internship	Internship	23PCH2INT	-	2	-	-	100	100
	Extra Credit Course	SWAYAM	As per UGC Recommendation						
	Total			**30**	**24**				**600**

III	Core Course– V (CC)	Physical Chemistry- II	23PCH3CC5	6	5	3	25	75	100
	Core Course- VI (CC)	Inorganic Chemistry-I	23PCH3CC6	6	5	3	25	75	100
	Core Practical – IV (CP)	Inorganic Chemistry –II (P)	23PCH3CC4P	6	4	6	40	60	100
	Core Choice Course– II (CCC)	A. Cyber Security	22PGCS3CCC2A	5	4	3	25	75	100
		B. Photochemistry and Advanced Chemical Kinetics	23PCH3CCC2B						
		C. Electro Chemistry	23PCH3CCC2C						
	Discipline Specific Elective Course-III (DSE)	A. Chemistry for Competitive Examinations	23PCH3DSE3A	4	3	2	-	100	100
		B. Bioorganic Chemistry	23PCH3DSE3B			3	25	75	
		C. Pharmaceutical Chemistry	23PCH3DSE3C						
	Generic Elective Course -I (GEC)	Nanoscience and Nanotechnology	23PCH3GEC1	3	2	3	25	75	100
	Extra Credit Course	SWAYAM	As per UGC Recommendation						
	Total			**30**	**23**				**600**
IV	Core Course–VII (CC)	Physical Methods in Chemistry	23PCH4CC6	6	5	3	25	75	100
	Core Choice Course– III (CCC)	A. Chemistry of Nanoscience	23PCH4CCC3A	6	4	3	25	75	100
		B. Biofuels	23PCH4CCC3B						
		C. Bioinorganic Chemistry	23PCH4CCC3C						
	Core Practical – V (CP)	Physical Chemistry - II (P)	23PCH4CC6P	6	5	6	40	60	100
	Generic Elective Course-II (GEC)	Corrosion and Pollution Management	23PCH4GEC2	3	2	3	25	75	100
	Project	Project Work	23PCH4PW	9	4	-	-	100	100
	Extension activity		23PGEA	0	1	0	-	-	-
	Total			**30**	**21**				**500**
	Grand Total			**120**	**91**				**2200**

Courses & Credits for PG Science Programmes

S. No	Courses	No. of Courses	No. of Credits	Marks
1.	Core Course – (CC)	7	35	700
2.	Core Choice Course– (CCC)	3	12	300
3.	Core Practical - (CP)	5	24	600
4.	Discipline Specific Elective-(DSE)	3	09	300
5.	Generic Elective Course -(GEC)	2	04	200
6.	Project	1	04	100
7.	Internship	1	02	100
8.	Extension activity	1	01	-
	Total	**22**	**91**	**2200**

The Internal and external marks for theory and practical papers are as follows:

Subject	Internal Marks	External Marks
Theory	25	75
Practical	40	60

Separate passing minimum is prescribed for Internal and External.

For Theory:

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks).

b) The passing minimum for End Semester Examinations shall be 40 % out of 75 marks (i.e. 30 marks).

c) The passing minimum not less than 50% in the aggregate.

For Practical:

a) The passing minimum for CIA shall be 40 % out of 40 marks (i.e. 16 marks).

b) The passing minimum for End Semester Examinations shall be 40 % out of 60 marks (i.e .24 marks).

c) The passing minimum not less than 50% in the aggregate.

For Project:

Marks for Dissertation : 80

Marks for Viva Voce : 20

Total marks : 100

Internal Component (Theory)

Component	Marks
Library	03
Attendance	03
Assignment & Seminar	04
CIA -I	7.5
CIA-II	7.5
Total	**25**

Internal Component (Practical)

Component	Marks
Observation	05
Record	10
Continual performance	10
Model	15
Total	**40**

Question Paper Pattern

PART A (10 X 2 = 20)

Answer all the questions

PART B (5 X 5 = 25)

Answer all the questions

PART C (3 X 10 = 30)

Answer any three questions

Semester I	Internal Marks:25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
23PCH1CC1	**ORGANIC REACTION MECHANISM-I**	**CORE**	**6**	**5**

Course Objective

- To learn the basic concepts of aromaticity and stereochemistry of various organic molecules
- To understand the feasibility and the mechanism of various organic reactions.
- To comprehend the techniques in the determination of reaction mechanisms.
- To understand the concept of stereochemistry involved in organic compounds.
- To correlate and appreciate the differences involved in the various types of organic reaction Mechanisms.

Prerequisites

Aromaticity, oxidation, reduction and symmetry

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recall and summarize the fundamentals of reaction intermediates, electrophilic and nucleophilic substitution reactions, aromaticity, and stereochemistry.	K1, K2
CO2	Interpret the concept to Huckels theory, thermodynamic and kinetic requirements of reactions: conformation analysis and substitution reactions	K3
CO3	Categorize the determination of intermediates, aromaticity, configuration and reactivity of aliphatic and aromatic compounds towards substitution reaction.	K4
CO4	Evaluate aromatic character, stereo analysis, pathway of reaction mechanism.	K5
CO5	Predict the intermediate, conditions and product of substitution mechanism.	K6

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	2	3	1	1	1	3
CO2	3	2	1	3	2	2	3	1	1	2
CO3	3	3	1	1	2	3	2	2	2	3
CO4	3	3	2	2	3	3	2	1	2	3
CO5	3	3	2	3	3	3	3	2	1	2

"1"– Slight(Low) Correlation "2"–Moderate(Medium)Correlation

"3"–Substantial(High) Correlation "-"indicates there is no correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	CONGNITIVE LEVEL
I	**Methods of Determination of Reaction Mechanism:** Reaction intermediates-transition state-energy profile diagrams - Thermodynamic and kinetic requirements of reactions – Hammond's postulate - Methods of determining mechanism: non-kinetic methods - product analysis - determination of intermediates – isolation - detection and trapping. Cross-over experiments - isotopic labelling - isotope effects and stereo chemical evidences. Kinetic methods - relation of rate and mechanism- Effect of structure on reactivity- Hammett and Taft equations - Linear free energy relationship - partial rate factor- substituent and reaction constants.	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5, K6**
II	**Aromaticity:** Aromatic character: Huckel's theory of aromaticity - three, four, five, six, seven and eight membered rings – other systems with aromatic sextet- concept of homo aromaticity and anti-aromaticity- Craig'srule – applications - consequences of aromaticity non-alteration in bond length -Huckel's MO calculation - Electron occupancy in - NMR concept of aromaticity and anti-aromaticity.	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5, K6**
III	**Stereochemistry and Conformational Analysis:** Stereoisomerism–optical activity and chirality – types of molecules exhibiting optical activity – R, S and E, Z configuration -	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5, K6**

	absolute configuration – chirality in molecules with non-carbon stereo centers (N, S and P) – molecules with more than one chiral centre. Biphenyls, allenes, spiranes and analogues- Atropisomerism- Helicity and chirality- Resolution–methods of resolution - Conformations of mono and di substituted cyclohexane system and decalin. Quantitative correlation between conformation and reactivity.			
IV	**Aromatic and Aliphatic Electrophilic Substitution:** Aromatic electrophilic substitution: Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation and diazonium coupling; Sulphur electrophiles: sulphonation - Halogen electrophiles: chlorination and bromination- Carbon electrophiles: Friedel- Crafts alkylation, acylation and arylation reactions- Aliphatic electrophilic substitution Mechanisms: S_E1, S_E2 and S_Ei-Mechanism and evidences.	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5, K6**
V	**Aromatic and Aliphatic Nucleophilic Substitution**: Aromatic nucleophilic substitution: Mechanisms - S_NAr, S_N1 and Benzyne mechanisms - Evidences - reactivity Effect of structure - leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles -Bucherer and	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5, K6**

	Rosenmund reactions, von Richter, Sommelet-Hauser and Smiles rearrangements - S_N1, ion pair, S_N2 mechanisms and evidences. Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon and vinyl carbon. S_N1, S_N2, S_Ni, and S_E1 mechanism and evidences - Swain- Scott, Grunwald- Winstein relationship - Ambident nucleophiles.			
VI	**Self-Study for Enrichment:** **((Not to be included for External Examination)** Rules of resonance–tautomerism -steric effects- Enantiomers and diastereomers- Bredt's rule- neighbouring group participation.	-	**CO1, CO2 CO3**	**K1, K2, K3, K4**

Text Books

1. Mukherji,S.MSingh.S.P.(2015).Reaction Mechanism in Organic Chemistry (Revised Edition):Trinity; New Delhi.
2. Kalsi.P.S.(1993).Stereochemistry.Wiley eastern limited; New Delhi.
3. Jagdambasingh.(2016).Organic synthesis: PragatiPrakashan.
4. Bansal.R.K.(1975).Organic Reaction Mechanisms.TataMcGrawHill.

Reference Books

1. March and Smith.M.B March's Advance Organic Chemistry Reactions,Mechanisms and Structure,7thEdition. (2013), Wiley, New York.
2. Finar.I.R,OrganicChemistryVol.II7th edition. (2009),Pearson, New Delhi.
3. Nasipuri.D, Stereo chemistry of organic compounds Principles, 2ndEdition. (2002), New Age International and applications.
4. Lowry. T. H. E and Richardson. K. S, Mechanism and Theory in Organic chemistry, 3rdedition.(1997),Benjamin Cummings Publishing, USA.

5. Carey.F. Aand Sundberg.R.J,Advanced Organic chemistry Part A and B,5th edition.(2007),Springer,Germany.

WebReferences

1. https://openstax.org/books/chemistry-2e/pages/12-6-reaction-mechanisms.
2. http://courses.washington.edu/medch562/pdf/MEDCH400_Stereochem.pdf
3. https://byjus.com/chemistry/substitution-reaction/
4. https://iscnagpur.ac.in/study_material/dept_chemistry/5.1_RRT_ARSN.pdf.

Pedagogy

Chalk and talk,PPT, Discussion,Assignment, Demo,Quiz, Seminar

Course Designers

Dr.C. Rajarajeswari

Semester I	Internal marks : 25		External Marks:75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**HRs/ WEEKS**	**CREDITS**
23PCH1CC2	**STRUCTURE AND BONDING IN INORGANIC COMPOUNDS**	**CORE**	6	**5**

Course Objective

- To articulate the learning of solid state in chemistry
- The subject lays a foundation to clusters and organometallic compounds

Prerequisites

Clusters, Solid state, organometallic compounds, Band theory

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course students will be able to	Cognitive Level
CO1	Predict the geometry of main group compounds and clusters.	K2, K3
CO2	Explain about the packing of ions in crystals and solid state.	K2, K3
CO3	Understand the various types of ionic crystal systems and analyze their structural features.	K3, K4
CO4	Explain the types of crystal growth methods and structures of organometallic compounds.	K4, K5
CO5	To understand the principles of band theory and solid state theory	K4, K5

Mapping with Programme Out comes

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**3**	**2**	**2**	**1**	**3**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**3**	**3**	**2**
CO5	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**

"1" – Slight or No Correlation "2" –(Moderate(/Medium) correlation

"3" – Substantial(High) Correlation "-" – indicates No Correlation

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Structure of main group compounds and clusters:** VB theory – Effect of lone pair and electro negativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Pauling's rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding inB-N(Boron nitride,Borazine) S-N (S_4N_4, S_2N_2, $(SN)_x$), P-N (Di and Triphosphazenes,), Poly acids – types, examples and structures- Borane cluster: Structural features of closo, nido, arachano and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster.	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5 K6**
II	**Organo metallic Compounds :** Hapticity of ligands- 18 Electron rule and its limitation-Classification of organometallic compounds – structure of methyl lithium, Zeise'ssalt and Ferrocene- Metal carbonyls – EAN rule – Mono and poly nuclear carbonyls – preparation, reactions and structure ($Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$,$Co_2(CO)_8$and Fe2(CO)9 –	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5 K6**

	Bonding in metal Carbonyls – Metal-ethylenic complexes – methods of formation –bonding – chemical properties.			
III	**Solid state Chemistry – I** Ionic crystals: Packing of ions in simple, hexagonal and cubic close packing, voids in crystal lattice, Radius ratio, Crystal systems and Bravis lattices, Symmetry operations in crystals, glide planes and screw axis; point group and space group; Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
IV	**Solid state Chemistry – II** Structural features of the crystal systems: Rock salt, zinc blende &wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures. Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**
V	**Band theory and defects in solids** Band theory – features and its application of conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors; Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and its effects	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5** **K6**

	due to dislocations.			
VI	**Self-StudyforEnrichment** **(Not to be included for External Examination)** High-valent metal Clusters and halide Clusters-Bragg's law, powder diffraction pattern. X-ray diffraction and Electron diffraction comparison		**CO1** **CO2**	**K2,** **K3**

TextBooks

1. Greenwood. (1996).Chemistry of the Elements, United Kingdom, Elsevier Science & Technology Books.
2. Kaesz, H., Adams, R., Shriver,D.,Kaesz,H.,Adams,R.,Shriver,D.(1990).The Chemistry of Metal Cluster Complexes.
3. Sharma, L. R., Puri, B. R., Sharma, L. R., Puri, B. R. (1976). Principles of Inorganic Chemistry: For B.Sc. and B.Sc.(Hons.) Classes of Indian Universities. India:S.Nagin.
4. Cotton, F. A., Wilkinson, G., Cotton, F. A., Wilkinson. (2007). Advanced Inorganic Chemistry,6th Edition, India: Wiley India Pvt. Limited.
5. Keiter, E.A. (2006). Inorganic Chemistry: Principles of Structure and Reactivity. India: Pearson Education.
6. Arthur, W. Adamson Paul, D.(1975).Fleischauer, Concepts of Inorganic Photochemistry. United Kingdom: Wiley.
7. West, A. R., (2014). Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd.,.
8. Bhagi, A.K., Chatwal, G. R. (2001). A textbook of inorganic polymers, Himalaya Publishing House.
9. Smart, L., Moore E. (2012). Solid State Chemistry – An Introduction, 4th Edition, CRC Press.
10. Purcell, K. F., Kotz, J. C.(1977). Inorganic Chemistry; W.B. Saunders company: Philadelphia.
11. Huheey, J. E., Keiter, E. A., Keiter R. L. (1983). Inorganic Chemistry; 4th ed.; Harper and Row: NewYork.

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1. Lee, J.D., (2008). ConciseInorganicChemistry,5thEdition.(2008).India:Wiley India Pvt. Limited.
2. Gurdeep Raj, (2020). Advanced Inorganic ChemistryVol-1,.KrishnaPrakashan.
3. Ferraudi, G. J., Ferraudi, G. J. (1988). Elements of Inorganic Photochemistry. United Kingdom: Wiley.
4. Pearson, R. G., Basolo, F., Pearson, R. G., Basolo, F. (1967). Mechanisms of Inorganic Reactions:A Study of Metal Complexes in Solution. United Kingdom: Wiley.
5. Sharma, R.K., Sharma, R. K.(2007). Inorganic Reaction mechanisms. India: Discovery Publishing House.
6. Douglas, D. E.. McDaniel, D.H., Alexander, J. J.(1994). Concepts and Models in Inorganic Chemistry, 3rd Ed, John Wiley & Sons, Inc., New York.
7. Tilley, R.. J. D.,(2013). Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication.
8. Rao, C. N. R., Gopalakrishnan, J., (1997). New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press.

WebReferences

1. https://www2.chemistry.msu.edu/courses/cem151/chap24lect_2019.pdf
2. http://www.vpscience.org/materials/Unit%203%20B%20Coordination%20chemistry.pdf
3. https://www.usb.ac.ir/FileStaff/2896_2019-4-18-0-9-32.pdf
4. https://www.uou.ac.in/sites/default/files/slm/BSCCH-101.pdf
5. https://www.chem.uci.edu/~lawm/11-16.pdf
6. **https://www.usb.ac.ir/FileStaff/5269_2018-9-18-10-21-39.pdf**

Pedagogy

Chalk and talk, PPT,Discussion, Assignment,Demo,Quiz, Seminar

CourseDesigners

Dr. K. Shenbagam

Semester I	InternalMarks:25		ExternalMarks:75	
COURSECODE	**COURSETITLE**	**CATEGORY**	**Hrs /Week**	**CREDITS**
23PCH1CC3	**MOLECULAR SPECTROSCOPY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**5**

Course Objective

- To understand, rotational and vibrational level transition in polyatomic molecules.
- To know the significance of Franck-Condon principle to interpret the selection rule, intensity and types of electronic transitions
- To interpret first and second order splitting pattern NMR signals of the molecules using correlation techniques such as COSY, HETCOR, NOESY.
- To learn the principle of ESR, EPR and Raman spectroscopy.
- To understand fragmentation pattern of molecules in Mass spectroscopy.
- To predict the structure of molecules using various spectral data.

Prerequisites

Electromagnetic radiation, molecular energy level, non-Rigid rotor, selection rules for spectroscopy

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Understand principle of various spectral techniques involving molecular absorption and emission of electromagnetic radiations.	K1, K2
CO2	Apply NMR and MS spectroscopic techniques in solving structure of organic molecules.	K3
CO3	Explain the principle, rules to analyses, compare and identify the structure of organic molecules using various spectral techniques.	K4
CO4	Discriminate structural and stereoisomers of compound using NMR,ESR and mass spectral techniques.	K5
CO5	Evaluate energy of rotational levels, isotopic mass of the elements.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	2	3	1	1	1	3
CO2	3	2	1	3	2	2	3	1	1	2
CO3	3	3	1	1	2	3	2	2	2	3
CO4	3	3	2	2	3	3	2	1	2	3
CO5	3	3	2	3	3	3	3	2	1	3

"1"–Slight (Low)Correlation "2"–Moderate(Medium)Correlation
"3"–Substantial (High)Correlation "-"indicates there is no correlation

SYLLABUS

UNIT	CONTENT	HOURS	COs	CONGNITIVE LEVEL
I	**Rotational and Raman Spectroscopy:** Rotational spectra of diatomic and polyatomic molecules- intensities of rotational spectral lines - isotopic substitution effect - non-rigid rotatorsRaman effect - pure rotational Raman spectra of linear and asymmetric top molecules - stokes and anti-Stokes lines- Vibrational Raman spectra - rule of mutual exclusion- rotational fine structure O and S branches - Polarization of Raman scattered photons.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
II	**Vibrational Spectroscopy:** Vibrations of molecules - harmonic and anharmonic oscillators - energy expression - vibrational wave functions – symmetry - selection rules - energies of spectral lines - hot bands - effect of isotopic substitution - Diatomic vibrating rotorvibrational - rotational spectra of polyatomic molecules - symmetry properties - overtone - combination frequencies- P, Q and R branches - parallel and perpendicular vibrations of linear and symmetric top molecules.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
III	**Electronic spectroscopy**: Electronic spectroscopy of diatomic moleculesFrank-Condon principle - dissociation and predissociation spectra- $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ transitions and their selection rules - Photoelectron Spectroscopy: Principle - photoelectron spectra of simple molecules - X-ray photoelectron spectroscopy (XPS) - Lasers: Laser action population inversion - properties of laser	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

	radiation examples of simple laser systems.			
IV	**NMR and Mass spectrometry:** NMR spectroscopy - Principle -Chemical shift, Factors influencing δ- shielding and deshielding. spin-spin interactions- spin decoupling- Nuclear over Hauser effect (NOE)- Factors influencing coupling constants- 2D NMR – COSY, NOESY Mass Spectrometry: Ionization techniques isotope abundance- molecular ion -base peak meta stable ions -fragmentation processes of organic molecules- deduction of structure through mass spectral fragmentation.	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
V	**ESR and Mossbauer Spectroscopy**: ESR- principle- selection rule- g value-hyperfine coupling parameter (A) –zero field splitting - Kramer's degeneracy – isotropy and anisotropy in g value- application of ESR to organic and inorganic system (H, CH3, p-benzosemiquinone and bis (salycylaldimine) copper (II) complex)- Principle of Mossbauer spectroscopy: Doppler shift - recoil energy. Isomer shift, quadrupole splitting - magnetic interactions - applications: high and low spin Fe and Sn compounds.	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
VI	**Self-study: (Not for final examination)** Problems based on joint application, PMR, CMR, and Mass. (Including reaction sequences), DEPT, INTEPT, Chemical spin decoupling of rapidly exchangeable protons (OH, SH, COOH, NH, NH2).	-	**CO1 CO2**	**K1 K2**

Text Books

1. Banwell C.N (2017), Fundamentals of molecular Spectroscopy, 4th edition, McGraw Hill, New Delhi.
2. Silverstein.P.M and Western.F.X (2014), Spectroscopic Identification of Organic compounds, 8th edition, John Wiley, New York
3. Kalsi.P.S (2016), Spectroscopy of Organic Compounds, 7th edition, New Age International Publishers, New Delhi
4. William Kemp (2019), Organic spectroscopy, 3rd edition, Macmillan publisher Pvt, Bangalure.
5. Williams D.H and Fleming I, Spectroscopic Methods in Organic Chemistry, 4 th Ed.,

Tata McGraw-Hill Publishing Company, New Delhi, 1988.
6. Drago R.S , Physical Methods in Chemistry; Saunders: Philadelphia, 1992

Reference Books

1. Drago R.S (2012), Physical Methods in Inorganic Chemistry; Affiliated East-West press Pvt. Ltd, New Delhi.
2. Kaur.K, (2014), Spectroscopy, 16th edition, PragatiPrakashan Educational Publisher.
3. Sharma Y. R (2016), Elementary organic spectroscopy, revised 4th edition, S. Chand &Co Ltd, New delhi.
4. Atkins P.W and de Paula J, Physical Chemistry, 7th Ed., Oxford University Press, Oxford, 2002.
5. Rahman A, Nuclear Magnetic Resonance-Basic Principles, Springer-Verlag, New York,1986.
6. Levine N.I, Molecular Spectroscopy, John Wiley & Sons, New York, 1974.

Web References

http://www.organic-chemistry.org/
http://www.organicworldwide.net/
http://www.ccdc.cam.ac.uk/products/csd/
http://www.nou.ac.in/econtent/Msc%20Chemistry%20Paper%20IX/MSc%20Chemistry%20Paper-IX%20Unit-5.pdf
http://www.rcsb.org/pdb/home/home.do
https://onlinecourses.nptel.ac.in/noc20_cy08/preview
https://www.digimat.in/nptel/courses/video/104106122/L14.html

Pedagogy

Chalk and talk, PPT, E-content, Discussion, Assignment, Demo, Quiz, Seminar

Course Designers

Dr.V.Sangu.

Semester I	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs / Week**	**CREDITS**
23PCH1CC1P	**ORGANIC CHEMISTRY-I (P)**	**CORE**	**6**	**5**

Course Objectives

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

Pre requisites

Separation of components, Qualitative analysis

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Apply the principles of separation in organic mixtures.	K1
CO2	Prepare the organic compounds by single stage method.	K2
CO3	Identify various functional group in organic compounds.	K3
CO4	Develop skills in separating techniques estimations and preparations.	K3
CO5	Analyze the nature of organic mixture containingtwo components.	K4

Mapping of CO with PO and PSO

CCOs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO 1	3	2	2	2	2	2	1	3	2	1
CO2	2	3	2	2	2	3	2	1	3	2
CO3	2	3	3	2	3	1	1	1	2	1
CO4	3	2	2	3	2	2	3	2	3	2
CO5	2	3	3	3	2	1	2	2	2	2

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬

"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

SYLLABUS

I. Separation and analysis

1. Two component mixtures.
2. Three component mixtures.

II. Estimations

1. Estimation of Phenol (bromination)
2. Estimation of Glucose (redox)
3. Estimation of Aromatic nitro groups (reduction)
4. Estimation of Glycine (acidimetry)
5. Estimation of Acetyl group in ester (alkalimetry)
6. Estimation of Hydroxyl group (acetylation)

III. Two stage preparations

1. p-Nitroaniline from acetanilide
2. 1,3,5-Tribromobenzene from aniline
3. Acetyl salicyclic acid from methyl salicylate
4. m-Nitrobenzoic acid from methyl benzoate
5. Benzilic acid from benzoin

Text Books

1. A R West, Solid state Chemistry and its applications, 2ndEdition (Students Edition), John Wiley & Sons Ltd., 2014.
2. A K Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.
3. L Smart, E Moore, Solid State Chemistry – An Introduction, 4th Edition, CRC Press, 2012.

Reference Books

1.D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994.
2. R J D Tilley, Understanding Solids - The Science of Materials, 2nd edition, Wiley Publication, 2013.
3. C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 199.

Web References

https://ocw.mit.edu/courses/3-091-introduction-to-solid-state-chemistry-fall-2018/video_galleries/lecture-videos.

Pedagogy

Demonstration and practical sessions

Course Designer

Dr.K.UmaSivakami

Semester I	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs / Week**	**CREDITS**
23PCH1DSE1AP	**ANALYTICAL INSTRUMENTATION TECHNIQUE (P)**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- To design chromatographic methods for identification of species.
- To analyze different constituents through instrumental methods of analysis.
- To evaluate different contaminants in materials using turbidimetry and conductivity measurements.
- To analyze constituents in organic materials using emission and absorptionspectal techniques.

Pre requisites

Chromatography, qualitative analysis and spectroscopy

Course Outcome and Cognitive Level Mapping

CO Number	COStatement Onthesuccessful completionofthe course, students willbeableto	Cognitive Level
CO1	Become familiar with fundamental concepts of electrical and instrumentation techniques.	K1
CO2	Observe the application of Instrumentation Techniques	K2
CO3	Interpretation and identification of the given spectra of various organic compounds arrived at from spectral instruments.	K4
CO4	Develop the core skills to parse existing chromatographic protocols and identify the key factors influencing a chromatography and calorimetric experiment	K5
CO5	To develop students' ability and skill to acquire expertise in calibration techniques and Interpretation of various compounds.	K5

Mapping of CO with PO and PSO

CCOs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO 1	3	2	2	2	2	2	1	3	2	1
CO2	2	3	2	2	2	3	2	1	3	2
CO3	2	3	3	2	3	1	1	1	2	1
CO4	3	2	2	3	2	2	3	2	3	2
CO5	2	3	3	3	2	1	2	2	2	2

"1" – Slight (Low) Correlation ¬ "2" – Moderate (Medium) Correlation ¬
"3" – Substantial (High) Correlation ¬ "-" indicates there is no correlation.

SYLLABUS

I. Electrical Experiments:

1. Determination of the equivalent conductance of a weak acid at different concentrations and verifying Ostwald dilution law. Calculation of the dissociation constant of the acid.
2. Conductometric titration of a mixture of HCl and CH_3COOH Vs NaOH.
3. Potentiometric titration of a mixture of HCl and CH_3COOH Vs NaOH
4. Potentiometric titration of FAS Vs $K_2Cr_2O_7$
5. Potentiometric titration of a mixture of Chloride and Iodide Vs $AgNO_3$.
6. Determination of the pH of buffer solution by EMF method using Quinhydrone and Calomel Electrode.
7. Potentiometric titration of KI Vs $KMnO_4$.
8. Analysis of soil
   i) Determination of pH of soil. ii) Determination of total soluble salts by conductometry

II. Analytical experiments

1. Determining the concentration of citric acid in soft drink using titration.
2. Determination of ascorbic acid in lime juice by titration.
3. Estimation of aspirin from tablet using titration method.
4. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode using pH-meter.
5. Separation of monosaccharide and metal ions present in a given mixture by paper chromatography.
6. Determination of chlorine in water using Colorimetry.
7. Separation of mixture of Azo dyes by TLC chromatography.
8. Estimation of chlorophyll in leaves and phosphate in waste water by colorimetry.
9. Estimation of Fe(II) by 1,10 phenonthroline using spectrophotometry.

III. Spectroscopic Techniques

Interpretation and identification of the given spectra of various organic compounds arrived at from the following instruments

1. UV-Visible
2. IR
3. NMR
4. ESR

Text Books

1. Vogel's Text book of Practical Organic Chemistry, 5th Ed, ELBS/Longman, England, 2003.
2. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*; 6th ed., ELBS, 1989.
3. J. D. Woollins, *Inorganic Experiments*; VCH: Weinheim, 1995.
4. B. Viswanathan and P.S.Raghavan, Practical Physical Chemistry, Viva Books, New Delhi, 2009.

Reference Books

1. N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Labmanual, S. Viswanathan Co. Pvt. Ltd, 2009.
2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011.
3. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
4. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th edition, McGraw Hill, 2009.
5. J. N. Gurthu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 1987.

Web References

1. https://bit.ly/3QESF7t
2. https://bit.ly/3QANOnX

Pedagogy

Demonstration and practical sessions

Course Designer

Dr.K.UmaSivakami

Semester I	Internal Marks: 25External Marks: 75			
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs / Week**	**CREDITS**
22PCH1DSE1BP	**NANOSCIENCE AND NANOTECHNOLOGY (P)**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- Covers the whole spectrum of nanomaterials ranging from overview, synthesis, properties, and characterization of nano phase materials to application including some new developments in various aspects.
- Provides an introduction to the theory and practice on Nanomaterials and various techniques used for the fabrication and characterization of nanostructures.

Prerequisites

Precipitation, reduction and absorption methods.

Course Outcome and Cognitive Level Mapping

CO Number	COStatement Onthesuccessful completionofthe course,students willbeableto	Cognitive Level
CO1	To foundational knowledge of the Nanoscience and related fields	K1
CO2	Understand in broad outline of Nanoscience and Nanotechnology.	K2
CO3	Acquire an understanding the Nanoscience and Applications	K3
CO4	Apply principles of basic science concepts in understanding, analysis and prediction of matter at Nano scale.	K3
CO5	Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment	K5

Mapping of COwithPO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2	2	1	3	2	2
CO2	2	3	2	3	2	3	2	1	3	2
CO3	2	3	3	2	3	1	1	2	2	1
CO4	3	2	2	3	2	2	3	2	2	2
CO5	2	3	3	3	2	1	2	2	2	2

"1" – Slight (Low) Correlation ¬"2" – Moderate (Medium) Correlation ¬
"3" – Substantial (High) Correlation ¬"-" indicates there is no correlation.

SYLLABUS

1. Synthesis of CuO nano particles by sonochemical method.
2. Synthesis of ZnO nano particles by sonochemical method
3. Synthesis of Carbon nano particles by Microwave Irradiation Method.
4. Characterization of nanoparticles by UV- Visible Spectrophotometer.
5. Synthesis of Silver Nanoparticles by Chemical reduction method and their UV-VIS absorption studies.
6. Synthesis of Iron Oxide Nanoparticles by Polyol method and their UV-VIS absorption studies.
7. Synthesis of ZnO Nanoparticles by Co-Precipitation Method.
8. Preparation of thiolated silver nanoparticles.
9. Synthesis of Nanoparticles from plant materials by Sono chemical Method.

Text Books

1. Edelstein, A.S., Cammaratra, R.C. (2017). Nanomaterials: Synthesis, Properties and Applications, Second Edition. United Kingdom: Taylor & Francis.
2. Wiederrecht, G. (2010). Handbook of Nanofabrication. Italy: Elsevier Science.
3. Altavilla, C., CilibertoE.(2017). Inorganic Nanoparticles: Synthesis, Applications, and Perspectives. United Kingdom: CRC Press.

Reference Books

1. Fritzsche, W., Köhler, M., Fritzsche, W., Köhler, M. (2008). Nanotechnology: An Introduction to Nanostructuring Techniques. Germany: Wiley.
2. Muller, A., A.K., Cheetham., Rao C.N.R. (2006). The Chemistry of Nanomaterials: Synthesis, Properties and Applications. Germany: Wiley.

Web References

1. https://www.researchgate.net/publication/229419482_Sonochemical_synthesis_size_controlling_and_gas_sensing_properties_of_NiO_nanoparticles
2. https://www.sciencedirect.com/science/article/pii/S1569441018301445
3. https://pubs.rsc.org/en/content/articlelanding/2019/nj/c9nj01360a
4. https://www.researchgate.net/publication/231240704_UreaMelt_Assisted_Synthesis_of_NiNiO_Nanoparticles_Exhibiting_Structural_Disorder_and_Exchange_Bias

Pedagogy

Table Work

Course Designers

1. **Dr. G. Sivasankari**
2. **Dr. R. Subha**

Semester I	Internal Marks:25	External Marks:75		
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs/Week**	**CREDITS**
22PCH1DSE1CP	**BIOCHEMISTRY(P)**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

CourseObjectives

- To expertise the student to identify and isolate various biomolecules.
- To acquire training to estimate the quantity of biomolecules present by applying biochemical techniques.

Prerequisites

Chromatographic techniques, biomolecules and plant pigments.

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recall and understand the techniques involved in isolation, separation and estimation of various biomolecules	K1 & K2
CO2	Develop and apply the skills in handling various chromatographic and colorimetric techniques	K3
CO3	Qualitatively and quantitatively analyze the biomolecules	K4
CO4	Exemplify in handling various chromatographic techniques of biomolecules.	K5
CO5	Interpret the importance of technical analysis required for various biomolecules	K6

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	3	2	2	3	2	2	3
CO2	3	3	2	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	2	3	3	3	3	2	2	3
CO5	3	3	3	3	3	2	3	3	3	3

"1"–Slight(Low) Correlation "2"–Moderate(Medium)Correlation

"3"–Substantial(High) Correlation "-"indicatesthereisnocorrelation.

Syllabus

I. EXTRACTION OF BIOMOLECULES

1. Starch from potato.
2. Casein from milk.
3. Oil from oil seeds.
4. Cellulose from plant material.

II. BIOCHEMICAL TECHNIQUES

1. Identification of amino acid by circular and ascending paper chromatography.
2. Separation of amino acids and carbohydrates in a mixture by paper chromatography.
3. Separation of lipids by thin layer chromatography.
4. Separation of a mixture of proteins and salt by column chromatography.
5. Separation of plant pigments using Chromatography techniques - TLC, Paper chromatography.

III. QUALITATIVE ANALYSIS OF BIOMOLECULES

1. Carbohydrate–Glucose, Fructose, Sucrose, Lactose and Starch.
2. Proteins – Precipitation reactions of proteins, Colour reactions of proteins, colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
3. Lipids–solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
4. Qualitative tests for nucleic acid.

IV. COLORIMETRIC ESTIMATION

1. Glucose by DNS method.
2. Protein by Biuret/Bradford and Lowry's method.
3. Uric acid.
4. Urea by DAM method.
5. Creatinine by Jaffe's method.
6. Phosphorous by Fiske and Subbarow's method.

Text Books

1. Rajan, S. &SelviChristy.R.(2018). Experimental Procedures in Life Sciences. CBS Publishers & Distributors.
2. Wilson, K.&Walker,J.(2000).Principles and Techniques of Practical Biochemistry.Fifth edition.Cambridge University Press.
3. Upadhyay&UpadhyayNath(2016). Biophysical Chemistry: Principles and Techniques.Himalaya Publishing House.

Reference Books

1. Hofmann, A. &Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology.8th edition.Cambridge University Press.
2. Wood,W. B.(1981).Biochemistry-Aproblem Approach.Addison Wesley.

Web References

1. http://nec.edu.np/Publications/Chemistry_LAB_Manual/Experiment%204.pdf
2. https://www.mlsu.ac.in/econtents/1616_Biochemical%20Tests%20of%20Carbohydrate,%20protein,%20lipids%20and%20salivary%20amylase.pdf
3. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files /2% 20 ESTIMATION% 20 OF%20PROTEIN%20BY%20LOWRY.pdf
4. https://orbitbiotech.com/estimation-of-reducing-sugars-by-dnsa-method/
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8575183/
6. http://atlas-medical.com/upload/productFiles/208011/Creatinine%20Package%20Insert.pdf

Pedagogy

Demonstration and practical sessions

Course Designers

Dr. P. Pungayee Alias Amirtham

Semester II	Internal Marks: 25			External Marks: 75
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CC4	**PHYSICAL CHEMISTRY - I**	**CORE**	**6**	**5**

Course Objectives

- To under quantum mechanical operators, thermodynamic probability.
- To understand and compare theories of chemical kinetics.
- To learn symmetry operation and point group of simple molecules.
- To predict the vibrational modes, hybridization using he concepts of group theory.

Prerequisites

Schrodinger equation, factors affecting rate of the reactions, probability, entropy, adsorption, absorption and adsorption isotherm.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recall postulates of quantum theory- operator- thermodynamic probability- and types of adsorption.	K1, K2
CO2	Solve Schrodinger equation, character table, various statistical models, theories of reaction rate and surface theories.	K3, K4
CO3	Explain Hermitian of operators, theories of unimolecular reactions, ensembles and microstates.	K4
CO4	Deduce wave equation for particle in a box, rigid rotor, harmonic oscillator, classical and quantum statistics.	K5
CO5	Evaluate angular and radial function, character table, unimolecular reactions and kinetic models for catalysis	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2	3	3	3	1	3
CO2	3	2	2	3	2	2	3	3	3	2
CO3	3	3	3	1	2	3	2	2	2	3
CO4	3	3	3	2	3	3	2	1	2	3
CO5	3	3	2	3	3	3	3	2	3	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Quantum Chemistry:** Quantum mechanical operators - linear and non-linear operators - Hermitian operators - postulates of quantum mechanics - time dependent and independent Schrodinger wave equation - solution of the Schrodinger equation for bounded states such as particle-in-one dimensional - box - harmonic oscillator - rigid rotor - solution of the Schrodinger equation for the hydrogen atom - radial - angular probability distributions - atomic orbitals - electron spin.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
II	**Group Theory:** Definition of a mathematical group - properties - group multiplication table - cyclic groups - subgroups - classes - symmetry elements - symmetry operation - determination of point group of simple molecules (H_2O, CO_2, NH_3, BF_3, HCHO, C_2H_4 and XeF_4 like molecules) - definition of reducible and irreducible representations - great orthogonality theorem - consequences (statement only proof not needed) - determinations of the characters for irreducible representation of C_2v - C_3v point groups using the orthogonality theorem to construct the character table.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

III	**Chemical Kinetics:** Theories of reaction rates - Arrhenius theory - hard - sphere collision theory of gas - phase reactions - activated complex theory or absolute reaction rate theory (ARRT) for ideal gas reactions (in terms of partition functions) - relation between activated complex theory and hard sphere collision theory - thermodynamic formulations of activated complex theory - Lindeman's - Hinshelwood theory of unimolecular reactions.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
IV	**Catalysis and surface phenomenon:** Homogenous and heterogeneous catalysis - effect of pH - temperature on enzyme catalysis - kinetics of heterogeneous catalysis - Langmuir - Hinshelwood and Langmuir - Rideal - Eley mechanism - adsorption - free energy relation at interfaces - Gibb's adsorption isotherm - physisorption – chemisorption - adsorption isotherms - Freundlich, - Langmuir.	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
V	**Statistical Thermodynamics:** Thermodynamic probability - most probable distribution - ensemble - postulates of ensemble overlapping - canonical - grand canonical - micro canonical ensembles - sterling approximation derivation - Maxwell-Boltzmann distribution law - Maxwell's distribution of molecular velocity - Maxwell-Boltzmann statistics - applications - Bose-Einstein - Fermi Dirac	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

	statistics - comparison of MB, FD and BE statistics			
VI	Self-study: (Not for final examination) Eigen value - eigen function - applications of quantum mechanics - black body radiation - photoelectric effect - hydrogen spectrum - need for quantum mechanics - postulates.		CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

Text Books

1. Prasad, R. K. (2006). Quantum Chemistry (3rd ed), New Delhi, New Age International Publishers.
2. Bhattacharya, P.K. (2014). Group Theory and its Chemical Application, New Delhi, Himalaya Publishing House.
3. Laidler, K.J. (2003). Chemical Kinetics (3rd ed), India, Pearson Education.
4. Gupta, M.C. (2003). Statistical Thermodynamics (2nd Ed), New Delhi, New Age International Publishers.
5. Puri, Sharma & Pathania (2018) Principles of Physical Chemistry (47th Ed), Jalandhar, Vishal publication.

Reference Books

1. McQuarrie, D. A. (2015). Quantum Chemistry, India, Viva Books.
2. Chandra, A.K. (1994), Introduction to Quantum Chemistry, (4th Ed.), India, Tata-McGraw-Hill.
3. Mahendra R. Awode (2002) Quantum Chemistry, (New Delhi), S. Chand and Co. Ltd.
4. Raj, G. Bhagi, A. and Jain, V. (2010). Group Theory and Symmetry in Chemistry, (3rd Ed.,), India, Krishna Prakashan.
5. Gurdeep Raj. (2016), Advanced Physical Chemistry, (4th Ed), Meerut, Krishna prakashan media.
6. Raman, K.V. (1990), Group theory and its applications to chemistry (3rd Ed), McGraw-Hill Education.

Web References

1. e-PG Pathshala – P-02- Physical Chemistry- I (Quantum Chemistry)
2. e-PG Pathshala – P-06- Physical Chemistry- I (Statistical thermodynamics, chemical

dynamics, electrochemistry)

3. https://www.bdu.ac.in/cde/SLM/M.Sc.%20Chemistry/Chemistry%20I%20Year/Physical_Chemistry/Unit1.doc.
4. https://youtu.be/ALwziZSRiqM
5. https://youtu.be/ACY-Wbudg0o
6. https://youtu.be/yO8v0nszUz8
7. https://nptel.ac.in/courses/104101124
8. https://ipc.iisc.ac.in/~kls/teaching.html

Pedagogy

Chalk and talk, PPT, E-content, Discussion, Assignment, Demo, Quiz, and seminar

Course Designer

- Dr. V. Sangu

Semester II	Internal Marks: 40		External Marks: 60	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CC2P	**INORGANIC CHEMISTRY - I (P)**	**CORE**	**6**	**5**

Course Objectives

- To perform the semi-micro qualitative analysis and to estimate the metal ions using photoelectric colorimeter.
- To examine the constituents of samples.

Prerequisites

Separation of cations and anions, quantitative analysis

Course outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Detection of ions in an aqueous solution of the salt.	**K2**
CO2	Explain the quantitative estimation and estimation of inorganic compounds.	**K3**
CO3	Identify and separate cations and anions in a sample substance and Interpret results, while observing responsible and scientific conduct.	**K3**
CO4	Analyze quantitatively inorganic components in the environment.	**K4**
CO5	Hands-on experience with technical instrumentation.	**K5**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2	2	1	3	2	1
CO2	2	3	2	2	2	3	2	1	3	2
CO3	2	3	2	2	2	1	1	1	2	2
CO4	2	3	2	2	2	2	1	2	2	1
CO5	2	3	2	2	2	1	1	1	2	2

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

1. Semi-micro qualitative analysis of a mixture containing two common cations (Pb, Bi, Ca, Cd, Fe, Cr, Al, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg,) and two less common cations (W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U, Li).

2. Quantitative Estimation of copper, iron, nickel, chromium and manganese ions using photoelectric colorimeter.

Text Book

1. Vogel. A. I (2000), Text Book of Quantitative Inorganic Analysis, Longman.
2. Ramanujam, V.V. (1988), Inorganic Semimicro Qualitative Analysis, National Pubs.
3. Svehla. G. (1987), Text Book of Macro and Semimicro Qualitative Inorganic analysis, Longman.

Reference book

Vogel, A. ITatchell. A.R, Furniss B.S, Hannaford.A. J &Smith, P. W. G, (1989), Vogel's Textbook of Practical Organic Chemistry, 5th Ed., Prentice Hall.

Web References

1. https://iscnagpur.ac.in/study_material/dept_chemistry/4.1_MIS_and_NJS_Manual_for_Inorganic semi-micro qualitative analysis.
2. https://byjus.com/chemistry/systematic-analysis-of-cations.
3. https://www.uou.ac.in/sites/default/files/slm/MSCCH-505L.pdf

Pedagogy

E-content, Demo, Hands on training

Course Designer

- Dr. K. Shenbagam

Semester II	Internal Marks: 25			External Marks: 75
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CCC1A	**ORGANIC REACTION MECHANISM-II**	**CORE CHOICE COURSE**	**6**	**4**

Course Objectives

- To learn about the oxidising and reducing agent.
- Enable the students to acquire surplus knowledge about the addition, elimination mechanism, pericyclic reactions and the chemistry behind the photolytic reactions.
- Guide the students to know the role of heterocyclic compounds in drug development.

Prerequisites

Addition, Elimination, cycloaddition, photoreaction and Heterocycles.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Outline the synthesis, reactivity of organic compounds, nature of reagents, and fundamentals of photochemistry.	**K1 & K2**
CO2	Interpret the reaction mechanism of various organic reactions including photochemical, pericyclic, redox and heterocycles.	**K3**
CO3	Classify the different types of addition, elimination, photolytic reactions and heterocyclic compounds.	**K4**
CO4	Categorize the reaction pathways and naming reactions.	**K5**
CO5	Predict the mechanism and products of organic reactions.	**K6**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	2	3	2	1	1	3
CO2	3	2	1	3	2	3	3	1	1	2
CO3	3	3	2	1	2	3	3	2	2	3
CO4	3	3	2	2	3	3	3	2	2	3
CO5	3	3	2	3	3	3	2	1	1	2

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Addition and Elimination:** Addition to carbon - carbon multiple bonds – electrophile - nucleophile - free radical addition - addition to carbonyl - conjugated carbonyl system with mechanisms - Knoevengal - Stobbe - Darzen's glycidic ester condensation - Reformatsky reaction - elimination reaction - mechanism of E1, E2, E1CB – stereochemistry - Hoffmann's - Zaitsev's rules - pyrolytic cis elimination - Chugaev reaction - Hoffmann exhaustive methylation - Cope elimination - Bredt's rule.	18	CO1, CO2, CO4, CO5	K1, K2, K3, K4, K5
II	**Organic Photochemistry:** Fundamental concepts - energy transfer - characteristic of photoreaction - photoreduction- photooxidation – photosensitization - classification of photo reactions of Ketones - enones - Norrish type I and II - Paterno-Buchi reaction - photo-Fries rearrangement - photochemistry of alkenes - aromatic compounds – Zimmerman's di-pi methane rearrangement - reaction of unactivated centres- photochemistry of α, β - unsaturated carbonyl compounds - Barton Reaction.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
III	**Pericyclic Reactions:** Concerted reactions- stereochemistry - orbital symmetry - correlation diagram - Frontier molecular orbital approach- Woodward-Hoffmann rules- electrocyclic reactions - cycloaddition reactions- selection rules -	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6

	sigmatropic rearrangements- selection rules with examples- 1,3 and 1,5 hydrogen shifts - Cope - Claisen rearrangements.			
IV	**Reagents in Organic Synthesis**: Oxidation- Baeyer-Villiger-Jacobsen epoxidation - Shi epoxidation- Jones reagent-PCC-PDC-IBX-DMP-CAN-$Cu(OAC)_2$-Bi_2O_3-Swern oxidation- Sommelet reaction- Elbs reaction-oxidative coupling -Prevost reaction - Woodward modification - reduction-palladium - platinum - rhodium - nickel based heterogeneous catalysts for hydrogenation -Wilkinson's catalyst -Noyori asymmetric hydrogenation- Luche reduction-Red-Al- $NaBH_4$ -$NaCNBH_3$- trialkylsilanes - trialkylstannane.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
V	**Heterocycles:** Nomenclature - synthesis - reactivity of aromatic heterocycles - pyrazole- isothiazole- triazole-pyrimidine- purines- triazines- pyridazines – pyrazines - synthesis - reactivity of non-aromatic heterocycles - tetra hydro furan- pyrrolidine - piperidine- oxirane- oxetane- oxazole -imidazole.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6
VI	**Self-Study for Enrichment:** (Not to be included for External Examination) Markovnikov's - Anti-Markovnikov's rule - syn-anti addition – elimination - Jablonski diagram - thermal - photochemical reactions - chemistry of simple heterocycles.	-	CO1, CO2, CO3	K1, K2, K3, K4

Text Books

1. Pine S.H, Hendrickson J B, Cram and Hammond, (1980), Organic Chemistry, McGraw Hill, New York, 4th edition.
2. March J, and Smith M.B,(2020), Advanced Organic Chemistry, Reactions, mechanisms and Structure, Wiley, 8th edition.

3. Carey F A and Sundberg R J,(2007), Advanced Organic Chemistry, Part A and Part B, Springer,5th Corrected edition.
4. Bansal. R .K, (1990), Reaction mechanism in Organic Chemistry, Tata McGraw Hill.
5. Finar I L, (2009), Organic Chemistry, Pearson Education Ltd., 6th edition.

Reference Books

1. Peter sykes (2009), A guide book to mechanism in Organic Chemistry, Pearson Education, 6th edition.
2. Raj K Bansal. (2009), Heterocyclic Chemistry, New Age International Publishers. 4th edition.
3. Gurdeep.R.Chatwal, (2015), Reaction Mechanism and Reagents in Organic Chemistry, Himalaya Publishing House.

Web References

1. https://www.chemistrylearner.com/addition-reaction.html.
2. http://www-oc.chemie.uni-regensburg.de/OCP/ch/chb/oc5/Photochemie-08.pdf.
3. https://edscl.in/pluginfile.php/2878/mod_resource/content/1/teachers%20notes.pdf.

Pedagogy

Chalk and talk, PPT, Discussion, Assignment, Demo, Quiz, Seminar.

Course Designer

- Dr. A. Sharmila

Semester II	Internal Marks: 25			External Marks: 75
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CCC1B	**CHEMISTRY OF NATURAL PRODUCTS**	**CORE CHOICE COURSE**	**6**	**4**

Course Objectives

- By the end of this course, the student will be familiar with definition, isolation and uses of natural products.
- The students will be able to know the general properties and methods of preparation of naturalproducts chemically and biosynthetically.

Prerequisites

Isolation, addition, elimination, substitution, oxidation, reduction reactions.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Differentiate the different types of alkaloids, terpenes, steroids, flavonoids and vitamins.	**K1**
CO2	Know the basic terms in natural product chemistry and their physiological significance.	**K2**
CO3	Evaluate the different methods of preparation of natural products.	**K3**
CO4	Recognize the most important building blocks employed in the biosynthesis of natural products.	**K4**
CO5	Elaborate general methods of structural elucidation of compounds of natural origin.	**K5**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	2	3	1	1	1	3
CO2	3	2	1	3	2	2	3	1	1	2
CO3	3	3	1	1	2	3	2	2	2	3
CO4	3	3	2	2	3	3	2	1	2	3
CO5	3	3	2	3	3	3	3	2	1	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Alkaloids**: Categorization of alkaloids- general methods of structural determination of alkaloids -synthesis - biogenesis of nicotine - quinine – morphine - atropine - sertonin.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Terpenoids and Carotenoid**: Classification of terpenoids - isoprene rules- structural elucidation - synthesis of geraniol- α-pinene - camphor - diterpenoids - carotenoid- introduction - structure - synthesis of β-carotene - lycopene.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Steroids:** Introduction - nomenclature of steroids - Blanc's rule - Barbier-Wieland degradation - oppenauer oxidation - Diel's hydrocarbon - chemistry of cholesterol - ergosterol -Vitamin-D.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Flavonoids and Isoflavonoids:** Occurrence, nomenclature and general methods of structure determination, isolation - structure elucidation -synthesis of kaempferol - quercetin - cyanidin- genestein.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Vitamins:** Classification - structure of water soluble - fat-soluble vitamins - plant and animal sources- vitamins as coenzymes-deficiency of vitamins and their effects.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

VI	**Self-Study for Enrichment:** (Not to be included for External Examination) Definition - isolation and purification of alkaloids- terpenes - flavonoids.	-	CO2, CO3	K2, K3

Text Books

1. Chatwal G.R, (1990), Natural Products Chemistry-Vol. I & II, Himalaya Bombay.
2. Agarwal, O.P, Goel Gorakhpur (1985), Chemistry of Natural Products-Vol. I & II:
3. Longmann E.L, London B.S, (2000), Organic Chemistry-Vol. I-II: I. L. Finar.
4. Sujatha V. Bhat, Nagasampige B.A & Sivakumar M, (2006), Chemistry of Natural Products:, 2nd reprint, Springer.

Reference Books

1. Dewick P.M (2009), Medicinal Natural Products: A Biosynthetic Approach", 2nd Edition, Wiley& Sons.
2. Graham Solomons T.W, Craig B. Fryhle, Scott A. Snyder (2013), Organic Chemistry, 11th Edition, International Student Version, John Wiley &Sons. Himalaya Publishing House.

Web References

1. https://chemnote.weebly.com/uploads/2/5/8/6/25864552/alkaloids.pdf.
2. https://www.vedantu.com/biology/steroid.
3. https://www.slideshare.net/TareqAspirant/a-short-note-on-vitamins.
4. https://www.tuscany-diet.net/2014/01/22/flavonoids-definition-structure-classification.
5. https://www.intechopen.com/chapters/62573.
6. https://gcwgandhinagar.com/econtent/document/1588068142ch-1.pdf.

Pedagogy

Chalk and talk, PPT, E-content, Discussion, Assignment, Demo, Quiz, Seminar

Course Designer

- Dr. C. Rajarajeswari

Semester II	Internal Marks: 25			External Marks: 75
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CCC1C	**MOLECULAR REARRANGEMENT**	**CORE CHOICE COURSE**	**6**	**4**

Course Objectives

- To learn about the reactions intermediates involved in rearrangement reactions.
- To learn about the basic concepts about the electrophilic and nucleophilic rearrangement reactions.
- To learn the concept and mechanism of rearrangement reactions.

Prerequisites

Reaction intermediates, nitrenes, carbenes, electrophilic, nucleophilic, naming reactions**.**

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Know the outline for determining nature of rearrangements.	**K1, K2**
CO2	Interpret the reaction mechanism in various organic reactions.	**K2**
CO3	Classify the different types of intermediates involving in organic rearrangement reactions.	**K3**
CO4	Recognize the technique of identifying reaction mechanism in various naming reactions.	**K4**
CO5	Predict the mechanism, different intermediates and product of molecular rearrangement reactions.	**K5**

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	2	3	1	1	1	3
CO2	3	2	1	3	2	2	3	1	1	2
CO3	3	3	1	1	2	3	2	2	2	3
CO4	3	3	2	2	3	3	2	1	2	3
CO5	3	3	2	3	3	3	3	2	1	3

Mapping of CO with PO and PSO

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Molecular Rearrangements:** Introduction - intermolecular - intra molecular rearrangement - intermediates - classification based on migration origin and migration terminus - rearrangement to electron - deficient carbon - Wagner - Meerwein rearrangement - pinacol rearrangement - Wolff rearrangement - benzyl - benzilic acid rearrangement - allylic rearrangement - Sommelet - Hauser rearrangement - Tiffeneau - Demjanov rearrangement.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Rearrangement to electron-deficient nitrogen:** Beckmann rearrangement - Schmidt rearrangement - Hofmann rearrangement - Curtius rearrangement - Lossen rearrangement - Neber rearrangement - Stieglitz rearrangement - rearrangements with acyl carbenes - Arndt-Eistert Reaction - diazo ketone reactions.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Rearrangement to electron-deficient oxygen:** Baeyer - Villiger oxidation - cumene hydroperoxide rearrangement - phenol rearrangement - Dakin reaction - free radical rearrangements - sigmatropic rearrangement – classification - [1,2] shift - [1,3] shift - [3,3] shift - Claisen rearrangement - Cope rearrangement.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

IV	**Migration from N- to ring carbon rearrangement:** Hoffmann Martius rearrangement - Orton rearrangement - benzidine - semidine rearrangement - Bamberger rearrangement - migration to electron rich carbon center - Fries rearrangement - Favorski rearrangement.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
V	**Free radical rearrangement** Introduction - addition - substitutions - fragmentations - homolysis and free radical displacement - Hunsdieker reaction - Birch reduction - acyloin condensation – Homobenzylic rearrangement - Barton rearrangement- Hoffmann-Loffler-Freytag reaction.	18	CO1, CO2, CO3, CO4, CO5	K1, K2,K3, K4, K5
VI	**Self-Study for Enrichment:** (Not to be included for External Examination) Aldol condensation - allylic rearrangement - Ullmann reaction - Sandmeyer reaction - Perkin reaction - photochemical reaction - thermal fission reaction - oxidation - reduction reaction.	-	CO1, CO2	K1 K2, K3

Text Books

1. Tewari, .K.S, Vishil, N.K, & Mehotra N.S (2001), A text book of org. chem – 1st edition, Vikas Publishing House Pvt Ltd., New Delhi.
2. Soni P.L (2005), Text Book of Organic chemistry, Sultans Chand, 1991, New Delhi.
3. Bahl & Arun Bahl (2005), Organic Chemistry, S. Chand and Sons, New Delhi.
4. Agarwal O.P (2002), Chemistry of Organic Natural Products, Vol 1 and 2, Goel Pub. House.
5. Gurdeep Chatwal (2002), Chemistry of Organic Natural Products, Vol 1 and 2, Goel Pub. House.

Reference Books

1. Sharma, Y.R & Vig O.P (1997), Elementary organic absorption spectroscopy – 1st edition, Goel Pulishers, Meerut.
2. Morrison R.T & Boyd R.N (1992), Organic Chemistry, 6th edition, PHI Limited, New Delhi.
3. Jerry March (1992), Advanced Organic Chemistry, 4th edition, John Wiley and Sons, New York.
4. Pine S.H (1987), Organic Chemistry, 5th edition, McGraw Hill International Edition, Chemistry Series, New York.

Web References

1. https://tmv.ac.in/ematerial/chemistry/kpb/SEM_IV_Honours_Rearrangement%20final.pdf
2. https://pt.slideshare.net/ranianjali/molecular-rearrangements-involving-electron-deficient-nitrogen-as-an-intermediate
3. https://tmv.ac.in/ematerial/chemistry/kpb/SEM_IV_Honours_Rearrangement.pdf
4. https://www.slideshare.net/RakeshAmrutkar/molecular-rearrangement-182395340
5. https://www.slideshare.net/VIKASMATHAD1/free-radicals-84891258

Pedagogy

Chalk and talk, PPT, E-content, Discussion, Assignment, Demo, Quiz, Seminar.

Course Designer

- Dr. K. Uma Sivakami

Semester II	Internal Marks: 40			External Marks: 60
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2CC3P	**PHYSICAL CHEMISTRY - I (P)**	**CORE**	**6**	**5**

Course Objectives

- To understand the principle of conductivity experiments through conductometric titrations.
- To evaluate the order of the reaction, temperature coefficient, and activation energy of the reaction by following pseudo first order kinetics.
- To construct the phase diagram of two component system forming congruent melting solid and find its eutectic temperatures and compositions. To determine the kinetics of adsorption of oxalic acid on charcoal.

Prerequisites

Basic knowledge in electrochemistry, kinetics, phase rule and adsorption theories.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statements On the successful completion of the course, students will be able to	Cognitive Level
CO1	Recall the principles associated with various physical chemistry experiments.	K1, K2
CO2	Scientifically plan and perform conductometric, kinetics, rast and adsorption experiments.	K3, K4
CO3	Calculate and process the experimentally measured values and compare with graphical data.	K4, K5
CO4	Interpret the experimental data scientifically to improve students' efficiency for societal developments.	K6
CO5	Comprehend the kinetics and mechanism of substitution reactions in octahedral and square planar complexes.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	3	3	3	2
CO3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	2	3	3

"1"– Slight (Low) Correlation "2"– Moderate (Medium) Correlation

"3"– Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

1. Study the kinetics of acid hydrolysis of an ester to determine relative strength of acids.
2. Study the kinetics of hydrolysis of methyl/Ethyl acetate catalyzed by hydrochloric acid at different temperatures and to determine the thermodynamic parameters.
3. Study the kinetics of the reaction between acetone and iodine in acidic medium by half-life method and determine the order with respect to iodine and acetone.
4. Study of effect of salt (ionic strength) on the kinetics of reaction between potassium persulphate and potassium iodide (second order reaction).
5. Construct the phase diagram of simple eutectic system to determine composition of given mixture.
6. Determine the freezing point curve of two component system forming compound.
7. Determine cryoscopy constant of the given solvent by Rast method.
8. Determination of critical solution temperature of phenol-water system.
9. Study the effect of added electrolyte on the CST of phenol-water system.
10. Adsorption of oxalic acid on charcoal & determination of surface area (Freundlich isotherm only).
11. Determination of molecular weight of the polymer by viscometer method.

Text Books

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

Reference Books

1. Yadav J.B, (2001). Advanced Practical Physical Chemistry, Goel Publishing House.
2. Gurthu, J. N., & Kapoor R, (1987) Advanced Experimental Chemistry, S. Chand and Co.

Web References

1. https://web.iitd.ac.in/~nkurur/2015-16/Isem/cmp511/lab_handout_new.pdf

Pedagogy

Chalk and talk, PPT, E-content, Discussion, Assignment, Demo, Quiz and Seminar

Course Designer

- Dr. V. Sangu

Semester II	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2DSE2A	**GREEN CHEMISTRY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- To know about twelve principles of green chemistry, eco-friendly synthesis using microwave, ionic liquid and phase transfer catalyst.
- To know the synthesis of organic compounds in greener way.
- To gain knowledge about the use of environmentally friendly practices in reducing pollution.

Prerequisites

Pollution, hazardous chemicals, toxic chemicals. catalyst, condensation, substitution, elimination, oxidation, reduction.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Describe the basics of green chemistry and organic synthesis.	**K1**
CO2	Understand the importance of solvents, solid-state reactions, phase transfer catalyst and alternative energy sources.	**K2**
CO3	Apply green synthesis for synthesizing different organic compounds.	**K3**
CO4	Analyze the applications of green synthesis.	**K4**
CO5	Create a new route for the synthesis of organic compounds.	**K5**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	2	2	2	2	2
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Introduction to Green Chemistry:** Introduction - need of green chemistry - twelve principles of green chemistry - planning a green synthesis - percentage atom utilization - evaluating the type of the reaction involved - selection of appropriate solvents - selection of starting materials - use of catalyst - international organizations promoting green chemistry.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1,K2,K3, K4,K5
II	**Organic Synthesis in Green Solvents:** Introduction, reactions in water - pericyclic reactions - Claisen rearrangement - Wittig-Horner reaction - Knoevenagel reactions - pinacol coupling - aldol condensation - benzoin condensation - Heck reaction - Wurtz reaction - Mannich reactions - organic synthesis in supercritical carbon dioxide - Diels-Alder reaction - Kolbe-Schmitt synthesis - reaction in ionic liquids - types - preparations - synthetic applications.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1, K2, K3, K4, K5
III	**Organic synthesis using ionic liquids:** Introduction - types of ionic liquids - preparation of ionic liquids - applications - conversion of epoxides to halohydrins - thiocyanation of alkyl halides - Biginelli reaction - synthesis of homoallylic amines - cyclic carbonates - tonalid - traseolide - 1-acetyl naphthalene - biotransformation in ionic liquids - transesterification reactions - ammoniolysis of carboxylic acids - synthesis of Z-aspartame.	18	CO 1, CO 2, CO 3 CO 4, CO 5	K1,K2,K3, K4,K5

IV	**Alternate Energy Processes in Chemical Synthesis:** Microwave assisted organic synthesis – introduction - reactions in water - Hofmann elimination - hydrolysis of benzyl chloride - benzamide - coupling reactions - reactions in organic solvents - Baylis - Hillman reaction – esterification - Fries rearrangement - synthesis of chalcones - ultrasound assisted organic synthesis - introduction - homogenous sonochemical reactions - Curtius rearrangement - organometallic reactions - addition reactions - heterogenous liquid - liquid reactions - solid-liquid reactions.	18	CO 1, CO 2, CO 3 CO 4, CO 5	K1,K2,K3, K4,K5
V	**Phase Transfer Catalysts:** Introduction - mechanism of phase transfer reaction - types - advantages of phase transfer catalyst - applications of phase transfer catalyst in organic synthesis - Darzen reaction - Michael addition - Benzoin condensation - Wittig reaction - oxidation reactions using permanganate - chromate - hypochloride - osmium tetraoxide - potassium ferricyanide - peroxides - reduction reactions.	18	CO 1, CO 2, CO 3 CO 4, CO 5	K1,K2,K3, K4,K5
VI	**Self-Study for Enrichment:** (Not to be included for External Examination) Properties of CO_2 - Phase diagram for CO_2 - Uses of CO_2 in dry cleaning - instrumentation - types of sonochemical reaction in ultrasound assisted green synthesis.	-	CO 1, CO 2	K1,K2

Text Books

1. Kumar, V. (2007) An Introduction to Green Chemistry. Vishal Publishing Co. Jalandhar.
2. Ahluwalia. V. K. An Introduction to Green Chemistry. Narosa Publishing.
3. Anastas. P. T., and Warner, J. C. (2008). Green Chemistry. Oxford University Press.

Reference Books

1. Ahluwalia. V. K., and Kidwai, M. (2007). New Trends in Chemistry. Anamaya Publishers. 2nd Edition.
2. Ahluwalia. V. K., and Varma, R. S. (2009). Green Solvents. Narosa Publishing. 1st Edition.

Web References

1. https://www.epa.gov/greenchemistry/basics-green-chemistry
2. https://www.scielo.br/j/jbchs/a/Fzh57FB7TrhBWRLnzkCCfDs/?lang=en#:~:text=The%20solid%2Dphase%20organic%20synthesis%20(SPOS)%20has%20emerged%20as,chemistry%20to%20discover%20new%20hits.&text=In%20SPOS%2C3%20the%20solid,to%20drive%20reactions%20to%20completion
3. https://www.organic-chemistry.org/topics/sonochemistry.shtm
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/05.organic_chemistry-ii/21.phase_transfer_catalysis/et/5550_et_et.pdf
5. https://doras.dcu.ie/18202/1/Robert_Ryan.pdf

Pedagogy

Chalk and talk, PPT, Discussion, Assignment, Demo, Quiz, Seminar.

Course Designer

- Dr. S. Devi

Semester II	Internal Marks: 25			External Marks: 75
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2DSE2B	**FORENSIC CHEMISTRY**	**DISCIPLINE SPECIFIC ELECTIVE**	**6**	**3**

Course Objectives

- To identify the physical and biological evidences.
- To asset the various system of finger prints, forgery and natural origin.
- To explore the processing and usage of explosives.

Prerequisites

Terminologies, fingerprint, counterfitting, explosions.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Identify the fundamental principles and functions of forensic science.	**K1**
CO2	Apply the principles of Spectroscopy in forensic science.	**K2**
CO3	Analyze the techniques involved in the field of forensics.	**K3**
CO4	Appraise the role of chemistry and other branches in forensics.	**K4**
CO5	Feasibility and evaluation of explosives.	**K5**

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	2	2	2
CO3	2	3	3	3	3	2	3	3	3	2
CO4	3	3	2	3	2	3	2	2	2	2
CO5	2	3	1	2	3	3	3	3	2	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Introduction to Forensic Science:** Functions of forensic science - historical aspects of forensic science - definitions - concepts in forensic science - scope of forensic science - need of forensic science - basic principles of forensic science - branches of forensic science - forensic science in international perspectives.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1,K2,K3, K4,K5
II	**Chemistry of Forensic Investigations:** Definition of physical evidence - classification of physical evidence - types of physical evidences - glass - soil - physical properties - comparing glass fragments - collection - preservation of glass evidence - forensic characteristics of soil - collection - preservation of soil evidence - fingerprints - fundamental principles of fingerprints - classification of fingerprints methods of detecting fingerprints - preservation of developed prints - document - voice examination - collection of handwriting exemplars - typescript comparisons - inks and papers - alterations - erasures - obliterations.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1, K2, K3, K4, K5
III	**Technological Methods in Forensic Science:** Chromatographic methods - fundamental - principles - forensic applications of thin layer chromatography - gas chromatography - liquid chromatography - spectroscopic methods - fundamental principles - forensic applications of ultraviolet - visible spectroscopy - infrared spectroscopy - atomic absorption spectroscopy - atomic emission spectroscopy - mass	18	CO 1, CO 2, CO 3 CO 4, CO 5	K1,K2,K3, K4,K5

	spectroscopy - X-ray spectrometry - colorimetric analysis - Lambert-Beer law.			
IV	**Forgery and Counterfeiting**: Detecting forgery in bank cheques / drafts - educational records (mark lists, certificates) using UV-light - alloy analysis using AAS to detect counterfeit coins - checking silverline water mark in currency notes - jewellery - detection of gold - purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamonds - natural - synthetic - glassy.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1,K2,K3, K4,K5
V	**Explosive and Explosion:** Introduction - classification of explosives - primary - secondary or high explosive - detonator pyro technique propellant IEDs - firing mechanism of IEDs - evaluation - assessment of explosion.	18	CO 1, CO 2, CO 3, CO 4, CO 5	K1,K2,K3, K4,K5
VI	**Self-Study for Enrichment:** (Not to be included for External Examination) Role of Forensic scientist in Post blast investigation - collection of samples - explosion effects - technical report frame work.	-	CO 1, CO 2, CO 3 CO4	K1,K2,K3, K4

Text Books

1. Eckert G. William, (1996), Introduction to forensic sciences, New york, washington, CRC, Press.
2. Kemp, W. (1991) Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire.
3. Henry, C. (2006) Physical Evidence in Forensic Science.
4. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.

Reference Books

1. Tiwari, R. K., & Nanda, B. K. (2014) Forensic Science in India: A vision for the 21st Century.
2. Nordby, J. J., & James, S. H. (2019). An Introduction to Scientific and Investigative Techniques
3. James, S. H., & Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press.

Web References

1. https://ga01000549.schoolwires.net/cms/lib/GA01000549/Centricity/Domain/463/Forensics%20Chap%2010%20Forgery.pdf
2. http://dfs.nic.in/pdfs/EXPLOsive.pdf
3. https://www.azolifesciences.com/article/Chromatography-in-Forensic-Science.aspx

Pedagogy

Chalk and talk, PPT, Discussion, Assignment, Demo, Quiz, Seminar.

Course Designer

- Dr. R. Subha

Semester II	Internal Marks: 25		External Marks: 75	
COURSE CODE	**COURSE TITLE**	**CATEGORY**	**Hrs. / Week**	**CREDITS**
23PCH2DSE2C	**ANALYTICAL CHEMISTRY**	**DISCIPLINE ELECTIVE COURSE**	**6**	**3**

Course Objectives

- To acquire the knowledge of basic principles and theory behind analytical techniques.
- To know the separation of chemical compounds from mixtures.
- To gain knowledge about the application of analytical techniques to analysis chemicalcompounds.

Prerequisites

Adsorption, elution, solubility, electromagnetic radiation.

Course Outcomes

Course Outcome and Cognitive Level Mapping

CO Number	CO Statement On the successful completion of the course, students will be able to	Cognitive Level
CO1	Describe the basic concepts of data analysis, chromatography, electroanalytical methods, thermal methods and flame photometry.	K1
CO2	Understand the theory of various analytical techniques.	K2
CO3	Illustrates the instrumentation, experimental and purification details of analytical techniques.	K3
CO4	Compare various analytical techniques based on their principle and applications.	K4
CO5	Evaluate the applications of data analysis, chromatography,electroanalytical methods, thermal methods and flame photometry.	K5

Mapping of CO with PO and PSO

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	3	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	3	2	3
CO3	3	3	2	3	3	3	3	3	2	2
CO4	3	3	2	2	3	3	3	2	2	2
CO5	3	3	2	3	3	3	3	3	2	3

"1" – Slight (Low) Correlation "2" – Moderate (Medium) Correlation

"3" – Substantial (High) Correlation "-" Indicates there is No Correlation.

SYLLABUS

UNIT	CONTENT	HOURS	COs	COGNITIVE LEVEL
I	**Introduction To Analytical Chemistry:** Analyticalchemistry - role of analytical chemistry - classification - advantages - limitations of analytical methods - safety in laboratory - errors - types - definitions of relative error - absolute error - significant figures - mean - median - standard deviation - sensitivity - detection limits – precision - accuracy - confidence limit - test of significance - Q - test, F - test - T - test - minimization of errors.	18	CO1, CO2, CO3, CO4, CO4	K1, K2, K3, K4, K5
II	**Chromatography I:** Chromatography - introduction - definition - types - principles - theories - experimental details - advantages - limitations - applications of paper chromatography - thin layer chromatography - liquid - liquid partition chromatography - column chromatography.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
III	**Chromatography II:** Introduction, principle, instrumentation, advantages, limitations and applications of gas chromatography, gel permeation chromatography, silver impregnated ion exchange chromatography. Principle, instrumentationand applications of high performance liquid chromatography, gas chromatography - mass spectroscopy.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
IV	**Purification techniques:** Purification of solid organic compounds - recrystallization - use of miscible solvents - use of drying agents - properties - sublimation - experimental techniques of distillation - fractional distillation - distillation under reduced pressure –	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5

	extraction - use of immiscible solvents - solvent extraction - chemical methods of purification.			
V	**Thermal Methods and Flame Photometry:** Thermogravimetry - Introduction - principle - instrumentation - derivative thermogravimetry analysis - factors affecting TGA - applications of TGA for quantitative analysis of calcium carbonate - copper sulphate pentahydrate - calcium oxalate hydrate - differential thermal analysis - Introduction - principle of working - factors affecting DTA - applications - flame photometry - introduction - principles - instrumentation - advantages - limitations - applications.	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
VI	**Self-Study for Enrichment** (Not to be included for External Examination) Methods of expressing accuracy and precision - fractional distillation - column chromatography - chemical methods of purification - gas chromatography - applications of TGA.	-	CO1, CO2, CO3	K1, K2, K3

Text Books

1. Skoog. D. A., West. D. M., & Holler. H. J. (1992). Fundamentals of Analytical Chemistry.
2. Chatwal, G. R., & Anand. S. (1999). Instrumental Method of Analysis. Himalya Publishing House, 13th reprint.
3. Srivastava. A. K., & Jain, P. C. Instrumental Approach to Chemical Analysis.
4. Allen J. Bard & Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications.

Reference Books

1. Skoog, D. A., Holler, F. J., & Crouch, R. (2006). Principles of Instrumental analysis. 6th Edition.
2. Vogel's. Textbook of Quantitative Chemical Analysis, Pearson Education. 6th Edition.

3. Kaur, H. Instrumental Methods of Chemical Analysis. Pragati Edition.

Web References

1. https://www.simplilearn.com/data-analysis-methods-process-types-article
2. https://www.britannica.com/science/chromatography
3. https://acikders.ankara.edu.tr/pluginfile.php/75185/mod_resource/content/0/Distillation.pdf
4. https://www.med.upenn.edu/robertsonlab/assets/user-content/documents/types-of-chromatography.pdf
5. https://soe.unipune.ac.in/studymaterial/ashwiniWadegaonkarSelf/621%20Unit%202.pdf

Pedagogy

Chalk and talk, PPT, Discussion, Assignment, Demo, Quiz, Seminar.

Course Designer

1. Dr. G. Sivasankari
2. Dr. S. Devi