DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE & SYLLABI
(For the students admitted from year 2023-2024 onwards)

Programme : M.Sc. Chemistry

JAMAL MOHAMED COLLEGE (AUTONOMOUS)
Accredited with A++ Grade by NAAC (4th Cycle) with CGPA 3.69 out of 4.0
(Affiliated to Bharathidasan University)
TIRUCHIRAPPALLI – 620 020

M.Sc. CHEMISTRY

Sem	Course Code	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
						CIA	ESE	
I	23PCH1CC1	Core - I	Solvents, Crystal Structures, Metallurgy and Nuclear Reactions	6	5	25	75	100
	23PCH1CC2	Core - II	Organic Reaction Mechanisms, Reagents, Terpenoids and Alkaloids	6	5	25	75	100
	23PCH1CC3P	Core - III	Inorganic Estimation and Complex Preparations - Practical	6	4	20	80	100
	23PCH1CC4P	Core - IV	Organic Estimation and Preparations - Practical	6	4	20	80	100
	23PCH1DE1A/B	Discipline Specific Elective - I		6	4	25	75	100
			Total	**30**	**22**			**500**
II	23PCH2CC5	Core - V	Stereochemistry, Organic Reactions and Steroids	6	6	25	75	100
	23PCH2CC6	Core - VI	Group Theory and Spectroscopy	6	6	25	75	100
	23PCH2CC7P	Core - VII	Inorganic Qualitative Analysis and Colorimetric Estimations - Practical	6	4	20	80	100
	23PCH2CC8P	Core - VIII	Qualitative Analysis of Organic Mixture and Chromatography Techniques - Practical	6	4	20	80	100
	23PCH2DE2A/B	Discipline Specific Elective - II		6	4	25	75	100
	23PCN2CO	Community Outreach	JAMCROP	-	@	-	-	@
	@Only grades will be given		**Total**	**30**	**24**			**500**
III	23PCH3CC9	Core - IX	Resonance, Photoelectron Spectroscopy of Inorganic Compounds and Bio-Medicinal Chemistry	6	6	25	75	100
	23PCH3CC10	Core - X	Organic Spectroscopy and Pericyclic Reactions	6	6	25	75	100
	23PCH3CC11	Core - XI	Industrial Chemistry	6	5	25	75	100
	23PCH3CC12P	Core - XII	Physical Chemistry Non-Electrical - Practical	6	4	20	80	100
	23PCH3DE3A/B	Discipline Specific Elective - III		6	4	25	75	100
	23PCH3EC1	Extra Credit Course - I*	Online Course	-	*	-	-	-
			Total	**30**	**25**			**500**
IV	23PCH4CC13	Core - XIII	Classical, Statistical Thermodynamics and Surface Phenomena	6	6	25	75	100
	23PCH4CC14	Core - XIV	Chemistry of Macromolecules	6	6	25	75	100
	23PCH4CC15P	Core - XV	Physical Chemistry Electrical - Practical	6	4	20	80	100
	23PCH4DE4A/B	Discipline Specific Elective - IV		6	4	25	75	100
	23PCH4PW	Project Work		6	4	-	100	100
	23PCNOC	Mandatory Online Course**	Online Course	-	1	-	100	100
	23PCH4EC2	Extra Credit Course - II*	Online Course	-	*	-	-	-
	23PCN4EC3	Extra Credit Course – III+	Innovation and Intellectual Property Rights	-	+	-	-	-
	*** Programme Specific Online Course for Advanced Learners** **** Any Online Course for Enhancing Additional Skills** **+ Course for Enhancing IPR Skills**		**Total**	**30**	**25**			**600**
			Grand Total		**96**			**2100**

DISCIPLINE SPECIFIC ELECTIVES

Semester	Course Code	Course Title
I	23PCH1DE1A	Solution Kinetics, Electrode Process and Quantum Mechanics
	23PCH1DE1B	Quantum Chemistry and Spectroscopy
II	23PCH2DE2A	Organometallics and Inorganic Spectroscopy
	23PCH2DE2B	Chemistry of Inorganic Complexes
III	23PCH3DE3A	Medicinal Chemistry
	23PCH3DE3B	Chemistry of Materials
IV	23PCH4DE4A	Green and Nano Chemistry
	23PCH4DE4B	Environmental Chemistry and Quality Control

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1CC1	Core-I	6	5	25	75	100

Course Title	Solvents, Crystal Structures, Metallurgy and Nuclear Reactions

SYLLABUS

Unit	Contents	Hours
I	**Acids, bases and solvents:** **1.1 Acids and Bases:** Lux-Flood concept, Cady-Elsey concept, Usanowich concept. Hard and soft acids and bases (HSAB Principle) – Classification, acid and base strength of hardness and softness, electro negativity of hardness and softness – applications of HSAB, Symbiosis. Differentiating and leveling solvents. **1.2 Solvents:** Classification, non-aqueous solvents - liq. NH_3, SO_2, CH_3COOH, BrF_3, H_2S, N_2O_4 and *HF*.	18
II	**Ionic crystals:** **2.1 Crystal Structure:** Packing of ions in crystals, Radius ratio rules – Calculation of limiting radius ratios for coordination number 3 to 6. Classification of ionic structures - AX type (ZnS, NaCl, NiAs, CsCl) and AX_2 type (CaF_2, TiO_2, SiO_2), Layer structure-CdI_2 – structures only. Lattice energy - Born-Lande equation – significance, Kapustinski equation. **2.2 Defect in crystals**: Stoichiometric defects - Schottky and Frenkel defects, non-stoichiometric defects - Metal excess – F-Centres, interstitial ions and electrons. Metal deficiency defects – Positive ions absent and extra interstitial negative ions. Semiconductor systems, rectifiers, transistors, photovoltaic cells. Super conductors – high temperature super conductors.	18
III	**Covalent and coordinate bonding** **3.1 Covalent bond** - M.O. theory – Symmetry and overlap – construction of molecular orbitals in homo and hetero nuclear diatomic molecules. Isoelectronic molecules and ions. **3.2 Coordinate bond** - Crystal field theory – Splitting of d-orbitals in O_h Symmetry –Strong and weak field ligands – CFSE – Calculation. Splitting in T_d symmetry and tetragonal symmetry – Jahn-Teller distortion - splitting pattern in square planar. *Factors affecting the magnitude of 10 Dq value* - Nature of the ligands - Spectrochemical series, Jorgensen's relation. π bonding and MO theory - Ligands with filled and empty π orbitals – Nephelauxetic effect.	18
IV	**Metallurgy and Inorganic Polymers:** **4.1 Extraction and Uses of Metals:** Metallurgy of Zr, Ge, Th and U – *uses of their important compounds* **4.2 Alloys and Intermetallic Compounds:** Effect of alloying, types of alloys – simple mixtures, solid solutions, substitutional alloys, interstitial alloys, Intermetallic compounds – Hume-Rothery's rules. Ferrous alloys – Definition, properties and uses. Non-ferrous alloys – types, applications. **4.3 Inorganic polymers:** Phosphorous based network polymers – ultra phosphate glasses, borophosphate glasses - Applications. **4.4 Rings:** Preparation and Structure of Borazines & Phosphazenes – Craigg and Paddock models - Dewar model – Preparation and Structure of sulphur-nitrogen ring system (S_4N_4, $N_4S_4F_4$)	18
V	**Nuclear Chemistry** **5.1 Radioactivity** - orbital electron capture, nuclear isomerism, internal conversion. Detection and determination of radioactivity - Nuclear radiation, Scintillation and Cherenkov Counter. Particle accelerators - Linear, Cyclotron, Synchrotron, Betatron and Bevatron. *Nuclear reactors* **5.2 Nuclear Reactions** - Transmutation, stripping and pick-up, spallation, fragmentation and scattering reactions – Sources of neutrons – Neutron activation and isotopic dilution analysis – applications.	18

VI	**Current Trends (For CIA only)** Recent advances in solar photovoltaic systems

……. Self Study

Text Books:

1. J. D. Lee, A New Concise Inorganic Chemistry, Oxford UniversityPress, 5th Edition, 2011
2. Wahid U. Malik, G. D. Tuli and R. D. Madan, Selected Topic in Inorganic Chemistry, S. Chand &Co., New Delhi, Reprint Edition, 2011
3. Gurdeep Raj, Advanced InorganicChemistry-Vol.-I, 32nd Edition, Krishna's Educational Publishers 2014
4. H.J. Arnikar, Essential of NuclearChemistry, 4th Edition, New Age InternationalPublishers, 2011

Reference Books:

1. Cotton and Wilkinson Advanced Inorganic Chemistry 6th Edition John Wiley & Sons, New York 2004
2. James E. Huheey, Ellen A. Keiter and Richard L. Keiter Inorganic Chemistry Principles of Structure and Reactivity 4th Edition Pearson Education,11th Impression, 2011
3. Bodie E. Douglas D. McDaniel andJohn Alexander Concepts and Models ofInorganic Chemistry 3rd Edition Wiley India Pvt.Ltd., New Delhi, 2006
4. Peter Atkins, TinaOverton, JonathanRourke, Mark Weller and FraserArmstrong Inorganic Chemistry 4th Edition Oxford UniversityPress, New Delhi, 2010
5. Maheswar Sharonand Madhuri Sharon, Nuclear Chemistry, Ane books Pvt. Ltd., New Delhi, Reprint, 2021

Web Resource(s):

1. https://nptel.ac.in/courses/104105033
2. https://nptel.ac.in/courses/104101121
3. https://onlinecourses.nptel.ac.in/noc23_cy21/preview

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the concepts of acids and bases, packing of ions in solids, crystal field theory and illustrate inorganic polymers and particle accelerators.	**K1 & K2**
CO2	Determine the hardness, softness of acids and bases and radioactivity.	**K3**
CO3	Classify acids, bases by HSAB principle, defects in crystals, nuclear reactions and compare the stability of complexes.	**K4**
CO4	Defend opinions of non-aqueous solvents, crystal structures, alloys and inter metallic compounds.	**K5**
CO5	Adapt HSAB principle, Born-Lande equation, Hume-Rothery rule,	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	3	2	2	3	2	2.4
CO2	3	3	3	3	3	3	2	3	3	2	2.8
CO3	3	3	2	3	3	3	3	2	1	3	2.6
CO4	3	3	3	3	2	3	3	3	3	3	2.9
CO5	3	3	2	3	3	3	3	3	3	3	2.9
Mean Overall Score											2.72
Correlation											High

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Mujafarkani

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1CC2	CORE -II	6	5	25	75	100

Course Title	Organic Reaction Mechanisms, Reagents, Terpenoids and Alkaloids

SYLLABUS

Unit	Contents	Hours
I	**1.1. NOMENCLATURE AND REACTION MECHANISM** IUPAC system of nomenclature for complex acyclic and alicyclic organic compounds, fused bicyclic compounds, Spiro compounds, **1.2. Reaction intermediates:** Carbenes, Singlet oxygen, and *benzyne – generation, stability, structure and reactivity*. Non-classical carbocations definition, generation and stability**.** **1.3. Methods of determining reaction mechanism**: Energy profile diagrams - Thermodynamic and kinetic control of organic reactions –intermediate versus transition state - isotopic effects – kinetic and non – kinetic methods of determination of reaction mechanisms. **1.4. Correlation analysis**: Linear free energy relations – Hammett equation – significance of sigma (σ) and rho (ρ) – applications, deviations and limitations – Taft equation and applications.	18
II	**SUBSTITUTION REACTIONS** **2.1.Aliphatic Nucleophilic Substitution** -Scope of SN reactions, stereochemical aspects of the substitution reactions, stereochemistry of SN^2 mechanism and SN^1 mechanism, Factors Affecting the Mode and Rate of a Reaction Mechanism, Nature of the substrate, Nature of the entering Group (Nucleophile) , Nature of the Leaving Group, Nature of the Solvent, Nature of the Neighbouring Group participation, SN^i mechanism (Substitution, Nucleophilic, Internal), Distinguishing features of SN^1 and SN^2 mechanisms. **2.2. Aliphatic Electrophilic Substitution**- Unimolecular Substitution Reactions (SE1), Evidence for the SE1 mechanism, Stereochemistry of SEl reaction. Bimolecular Substitution Reaction (SE2), SE2 (Front) and SE2 (Back) Evidence and Stereochemistry - SEi mechanism Evidence and Stereochemistry. Effect of various factors on aliphatic electrophilic substitution,-Effect of substrate, Effect of leaving group-Effect of solvent, **2.3. Aromatic Electrophilic Substitution**, -Effect of substitutents on Electrophilic Aromatic Substitution, Nucleophilic Aromatic Substitution, Mechanism- Unimolecular Mechanism (SN1), Biomolecular mechanism (SN2), **2.4**. **Aromatic Nucleophilic substitution** – Orientation of the Substituents - Rules of orientation -ortho and para Directing substituents - Meta-Directing Groups, third substitution in the Benzene Nucleus.	18
III	**Addition Reaction and Elimination Reaction** **3.1. Addition Reaction**-Addition to cyclic compound, Addition to atoms having abnormal valency, Addition to two adjacent atoms, Addition to carbon-carbon double bonds. **3.2**. **Electrophilic addition**- Addition of hydrogen halides to symmetrical olefins and unsymmetrical olefins**,** *Hydroboration*, Epoxidation, hydroxylation, Ozonolysis, Addition of hypohalous acids, Compounds having more than one unsaturated centre. Some Individual Conjugated Dienes -1,3-Butadiene, Diels- Alder Reaction, Components of Diels- alder reaction- dienophiles and dienes, 1,3- Dipolar additions, **3.3. Nucleophilic Addition**- Addition to Acrylonitrile, Cyanoethylation, Addition to α, β - unsaturated carbon compounds, Michael Addition, Hydroboration - Oxidation, Hydroboration Mechanism, Addition to alkynes, addition to Carbon-Nitrogen triple bond. **3.4. Elimination Reaction**-Types of elimination reactions, Mechanism of β-eliminations, Mechanism of bimolecular Elimination (E2), Elimination from conjugate mechanism (E1cB), and Unimolecular mechanism (E1). orientation of the double bond -Bredt's rule, Saytzeff rule and Hofmann rule, Dehydrohalogenation, dehydration of alcohols, dehalogenation.	18

IV	**REAGENTS IN ORGANIC SYNTHESIS** **4.1 Reducing Reagents:** Reduction of CO to CH_2 in aldehydes and ketones - Wolff-Kishner reduction and Huang-Minlon modification. Metal hydride reduction - $NaCNBH_3$, $Na(OAc)_3BH$, Reduction by dissolving metals–sodium-liquid alcohol, sodium-liquid ammonia. Tin-hydrochloric acid, Zinc-hydrochloric acid, zinc-acetic acid, Magnesium-amalgam. Stannous chloride, sodium metabisulphite and Baker's Yeast. **4.2 Oxidizing Reagents:** $K_2Cr_2O_7/SO_4$ (Jones reagent), Selenium dioxide CrO_3-pyridine (Collin's reagent), PCC (Corey's reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane), DMSO based reagents (Swern oxidation). Oxidation involving C-C bond cleavage using HIO_4, CrO_3 (cycloalkanones). Oxidation of C=C using $NaIO_4$ and OsO_4, aromatic rings using RuO_4. Oxidation of aldehydes and ketones with H_2O_2 (Dakin reaction), with per acid (Baeyer-Villiger oxidation).	18
V	**TERPENOIDS AND ALKALOIDS** **5.1 Terpenoids:** Classification of Terpenoids - Structural elucidation and medicinal uses of Camphor and Zingiberene (synthesis not required). **5.2 Alkaloids:** Classification of alkaloids- Structural elucidation and medicinal values of quinine, and Papaverine (synthesis not required). **5.3. Carotenoids:** Classification, structural elucidation of α-carotene and β- carotene (synthesis not required) **5.4.Flavones:** Classifications of flavones, Structural elucidation of flavone and flavonal (synthesis not required).	18
VI	**Current Trends (For CIA only)** Endo fullerene-preparation and uses	

……. Self Study

Text Book(s):

1. Raj K. Bansal, Heterocyclic Chemistry, New Age International Publishers, 5th Edition, 2014.
2. V.K. Ahulwalia & Rakesh Kumar, Organic Reaction Mechanism, Narosa Publishing House , 3rd edition, 2009.
3. Mechanism of Organic Chemistry, Arunabha Sen., Books & Allied (P) Ltd.,K.S. ,2nd edition, 2010
4. Francis A. Carey Richard J. Sunberg, Advanced Organic Chemistry, Springer International Edition, 5th Edition, 2012
5. Gurdeep Chatwal, Organic Chemistry of Natural Products, Himalaya Publishing House, Vol.I & II Revised 5th Edition , 2005

Reference Book(s):

1. S.P. Shukla and G.L Trivedi, Modern Organic Chemistry, Rajendran Printers Pvt. Ltd., New Delhi, Millinium Edition, 2000,
2. Subrata Sen Gupta, Organic Chemistry, oxford university Press, Second impression 2017.
3. F.A.Carey and R.J.Sund berg , Advanced organic Chemistry, Plenum Publications, Vol I and II – 3rd Edition ,1984.
3. O.P. Agarwal, Reactions and Reagent in Organic Chemistry, Goel Publishing House ,Meerut, 5th Edition, 2005.
4. J.N. Gurtu and R.Kapoor, Organic Reactions and Reagents, Sultan Chand Company Pvt.Ltd. 1st Edition, 1988
5. G.R.Chatwal , Reaction and Reagents in Organic Chemistry, Himalaya Publishing House,2019.

Web Resources:

1. Web Reference: https://onlinecourses.nptel.ac.in/noc20_cy26/preview
2. Web Reference: https://swayam.gov.in/nd2_ugc19_ch01/preview
3. Web Reference: https://onlinecourses.swayam2.ac.in/cec23_cy03/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO statement**	**Cognitive Level (K-Level)**
CO1	Recognise and write the IUPAC nomenclature for different types of organic compounds.	**K1 & K2**
CO2	Select the substrate, solvent, attacking nucleophile in the nucleophilic and electrophilic substitution reactions.	**K3**
CO3	Categorize different types of addition and elimination reactions	**K4**
CO4	Choose the reagents used for the synthesis of novel organic compounds.	**K5**
CO5	Design the molecules having structure analogues	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	2	3	2	3	2	3	2.8
CO2	2	3	3	3	3	3	3	2	2	2	2.6
CO3	3	2	3	2	3	3	2	3	3	2	2.6
CO4	3	2	3	2	3	3	3	2	2	3	2.6
CO5	3	2	3	2	2	3	2	2	3	2	2.4
Mean Overall Score											2.6
Correlation											High

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. Riaz Ahamed

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1CC3P	Core – III	6	4	20	80	100

Course Title	Inorganic Estimation and Complex Preparations - Practical

SYLLABUS

Contents	Hours
I. Estimation of the following metal ions by volumetric and gravimetric / Complexometric methods: **50 Marks** 1. Cu (V) Ni (G/C) 2. Cu (V) Zn (G/C) 3. Cu (V) Mg (G/C) 4. Zn (V) Cu (G/C) 5. Fe (V) Zn (G/C) Note: V - Volumetric G -Gravimetric C - Complexometric **II. Complex Preparations:** **25 Marks** 1. Tetramminecopper(II)sulphate 2. Potassiumtrioxalatochromate(III) 3. Hexathiourealead(II)nitrate 4. Potassiumtrioxalatoaluminate(III) 5. Tristhioureacopper(I)chloride 6. Tristhioureacopper(II)sulphate 7. Hexaamminecobalt(III)chloride 8. Chloropentaamminecobalt(III)chloride **III. Viva-Voce:** **05 Marks** **Scheme of valuation** **For Estimation:** Procedure writing-10 marks **For Complex Preparation:** Quantity of crude sample– 15 marks Quality of recrystalised samples - 10 marks **Results:** 1-2% -40 marks 2-3% -35 marks 3-4% -30 marks >4% -20 marks	**90**

Text Books:

1. Vogel A I, A Text Book of Quantitative Inorganic Analysis, Longman Group, 3rd Edition,1972
2. Vogel A I, Text Book of Macro and Semi micro Qualitative Inorganic Analysis, 5th Edition,1979

Reference Books:

1. Sundaram, Krishnan, Raghavan, Practical Chemistry (Part II), S. Viswanathan Co. Pvt., 1996.
3. J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Vogel's text book of Quantitative Chemical Analysis, Longman Scientific and Technical, 5th Edition, 1999.

Web Resources:

1.https://www.slideshare.net/DrSSreenivasa/msc-inorganic-chemistry-laboratory-manual-complex-preparations
2. https://www.youtube.com/watch?v=s7pXbV9dumI

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Understand the principle of volumetric and gravimetric analysis and also demonstrate the preparation of metal complexes	**K1 & K2**
CO2	Apply the principle of volumetric and gravimetric in the estimation of metal ions in a mixture of metal ions in a solution	**K3**
CO3	Analyse the specific reagents required for the estimation of metal ions.	**K5**
CO4	Estimate the quantity of metal ions present in the mixture of the solution	**K3**
CO5	Develop a procedure for the preparation and purification of metal complexes.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2.7**
CO2	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2.6**
CO3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2.4**
CO4	**3**	**2**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.6**
CO5	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**2**	**3**	**1**	**2.3**
Mean Overall Score											**2.52**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Syed Ali Padusha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1CC4P	Core - IV	6	4	20	80	100
Course Title	Organic Estimation and Preparations - Practical						

SYLLABUS	
Contents	**Hours**
Quantitative Analysis of Organic Compounds – 50 Marks 1. Estimation of Phenol 2. Estimation of Aniline 3. Estimation of Ethyl Methyl Ketone 4. Estimation of Glucose 5. Estimation of Ascorbic acid **Two Stage Preparations – 25 Marks** 1. Acetylsalicylicacid from methylsalicylate 2. 1,3,5 – Tribromobenzene from Aniline 3. p-Nitroanilinefromacetanilide 4. p-Bromoaniline from acetanilide 5. Benzilic acid frombenzoin 6. Benzaldehyde to chalcone epoxide via chalcone 7. Cyclohexanone to caprolactone via cyclohexanone oxime **Viva-Voce – 05 Marks** **Scheme of Evaluation** **For Estimation:** Procedure writing -10 marks Results: 1-2% - 40 marks 2-3% - 35 marks 3-4% - 30 marks >4% - 20 marks **For Two Stage Preparations:** Quantity of crude samples (stage I & II) =7.5+7.5=15 marks Quality of recrystalised samples (stage I & II) = 5 + 5=10 marks	**90**

Text Books:
1. Arun Sethi, Systematic Lab Experiments in Organic Chemistry, New Age International (Pvt) Limited, 1st Edition, 2003. 2. Arthur I. Vogel, Elementary Practical Organic Chemistry, Pearson, 1st Edition, 2011. 3. Dhruba Charan Dash, Analytical Chemistry, PHI Learning Pvt Ltd, 2nd Edition, 2017.
Reference Books:
1. Arthur I. Vogel, A Text Book of Practical Organic Analysis, Longman, 5th Edition, 1989 2. F G Mann & B C Saunders, Practical Organic Chemistry, Orient Longman, 4th Edition, 2004.
Web Resource(s):
1. https://egyankosh.ac.in/bitstream/123456789/15894/1/Experiment-10.pdf 2.http://www.wbnsou.ac.in/student_zone/courses/science/laboratory/chemistry/20200206_Manual_for_Chemistry_Laboratory.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Estimate the organic compounds for its quality and quantity	**K1 &K2**
CO2	Develop the intellectual and psychomotor skills by imparting knowledge in quantitative analysis.	**K3**
CO3	Perform recrystallization techniques to get pure compounds	**K4**
CO4	Assess the purity of the compounds	**K5**
CO5	Design the synthetic procedure for the preparation of new molecules	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2.4**
CO2	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2.4**
CO3	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2.3**
CO4	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.1**
CO5	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.1**
										Mean Overall Score	**2.26**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. A. Zahir Hussain

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1DE1A	Discipline Specific Elective-I	6	4	25	75	100

Course Title	Solution Kinetics, Electrode Process and Quantum Mechanics

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Kinetics of Solutions, Catalysis and Fast reactions** **1.1** Solution Kinetics: rates of chemical reactions in solution compared to the gas phase, factors influencing reaction rates in solutions. Application of ARRT to solution kinetics, effect of ionic strength-primary and secondary kinetic salt effect, effect of dielectric constant – double sphere and single sphere model, influence of pressure on reaction rates in solution – significance of volume of activation. **1.2.** Homogeneous catalysis: *Acid-base catalysis – general and specific acid-base catalysis*, mechanism of acid-base catalysis, influence of pH on rate constant of acid-base catalysis, Acidity function - Hammett-Deyrup acidity function, Bronsted catalytic law. Enzyme catalysis- Michaelis-Menten law, influence of pH and temperature on enzyme catalysis. **1.3** Fast reactions: Study of kinetics by stopped flow technique, relaxation methods - T and P jump methods, flash photolysis and magnetic resonance methods (NMR & ESR). (Problems from 1.1)	**18**
II	**Electro Kinetic Phenomena and Electrode Kinetics** **2.1** *Debye-Huckel-Onsager theory of strong electrolytes*, Debye Huckel limiting law, activity coefficient at higher concentration - Bjerrum model. Electrical double layer potential – zeta potential, theory of multiple layers at electrode - Helmholtz, Guoy-Chapmann, Stern, Devanathan models. Electro kinetic phenomena – electrophoresis, electrosmosis, streaming potential and sedimentation potential. Electro capillary phenomena – capillary rise method and determination of interfacial tension. **2.2** Process at electrodes – rate of charge transfer, current density, Butler-Volmer equation, Tafel equation. **2.3** Principles of electro deposition of metals, electro chemical corrosion of metals, construction and use of Pourbaix and Evans diagrams, methods of prevention of corrosion.	**18**
III	**Basic concepts of Quantum Mechanics** **3.1.** Classical mechanics- *general principles, basic assumptions, postulates of classical mechanics, conservation laws, Lagrange's and Hamilton's equations of Motion (no derivation)*. Functions – definition, implicit and explicit functions, odd and even functions, integrals of odd and even functions, set of functions, Eigen functions and Eigen values, orthogonality, normalization and orthonormal functions. **3.2.** Operators - algebra of operators, commutation relations, linear, angular momentum, Laplacian, Hermitian and Hamiltonian operator, Hermitian property of operators. **3.3.** Postulates of quantum mechanics – solving the Schrödinger wave equation (SWE) to simple systems viz., particle in one and three dimensional boxes, Bohr's correspondence principle. (Problems from functions, operators, 1D and 3D boxes).	**18**
IV	**Applications of Quantum Mechanics-I** **4.1** Setting and solving Schrödinger wave equation for harmonic oscillator, rigid rotator, hydrogen and hydrogen like atoms (He^+ and Li^{2+}). Significance of n, l and m. Shapes of atomic orbitals - radial and angular probability distribution functions. **4.2** Approximation methods - linear variation principle, application to hydrogen and helium atoms, perturbation method for non-degenerate systems, application of perturbation theory to helium atom.	**18**

V	**Applications of Quantum Mechanics-II** **5.1** Two electron systems – symmetric and anti-symmetric wave functions, spin of electrons and Pauli's principle and Slater determinant, Hartree-Fock self consistent field theory, Slater type orbitals – Slater rules, orbital energies. **5.2** Theory of chemical bonding (diatomic molecules) – Born-Oppenheimer approximation, LCAO-MO and VB treatments of the hydrogen molecule, Huckel's molecular orbital (HMO) theory and its applications to ethylene, allyl radical and butadiene (linear), principle of hybridization – sp, sp^2 and sp^3.	**18**
VI	**Current Trends (For CIA only)** Recent Trends in nano-modified electrodes - applications and advantages	

……. Self Study

Text Books:
1. G. L. Agrawal, Basic Chemical Kinetics, Tata McGraw Hill, Reprint- Indian Edition, 1999. 2. John O'M Bockris and A. K. N. Reddy, Modern Electrochemistry, Anne Book House, India, Volume 2, Revised Edition, 2008. 3. Keith J. Laidler, Chemical Kinetics, Pearson Education, 3rd Edition, 2011. 4. R. K. Prasad, Quantum Chemistry-Through Problems and Solutions, New Age Publications, 2nd Edition, 1997. 5. A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw Hill, 4th Edition, 2010.
Reference Books:
1. D.R. Crow, Principles and Applications of Electrochemistry, Chapman and Hall, London, 4th Edition, 2004. 2. J. N. Gurtu and A. Gurtu, Advanced Physical Chemistry, 18th Edition, Pragati Prakashan Publications, Meerut, 2015. 3. Gurdeep Raj, Chemical Kinetics, Revised Edition, Goel Publishing House, Meerut, 2021. 3. F. L. Pillar, Elementary Quantum Chemistry, Dover Publications, Inc. Mineola, New York, 2nd Edition, 2003. 4. I. N. Levine, Quantum Chemistry, Prentice Hall of India, Pvt. Ltd., 7th Edition, 2016.
Web Resources:
1. https://archive.nptel.ac.in/courses/104/101/104101124/ 2. https://youtu.be/MwRZrDDjouo 3. https://youtu.be/k3Y_tONFQTU

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember and understand the concepts of kinetics of solutions, electrodes, fast reactions and quantum mechanics	**K1, K2**
CO2	Apply quantum mechanics in solving SWE to single and multi particle systems	**K3**
CO3	Compare the theories of multiple layers, acid-base catalysis and appreciate their significances	**K4**
CO4	Evaluate HFSC, HMO, VB and MO theories to simple molecules	**K5**
CO5	Construct Slater's determinant to molecules and to solve it	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3	3	3	3	3	3	3.0
CO2	3	3	2	1	2	3	2	1	1	1	1.9
CO3	3	3	2	3	3	3	2	1	2	3	2.5
CO4	3	2	1	1	2	3	2	1	1	1	1.7
CO5	3	1	1	1	1	3	2	1	1	1	1.5
Mean Overall Score											2.12
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Seeni Mubarak

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PCH1DE1B	Discipline Specific Elective-I	6	4	25	75	100

Course Title	Quantum Chemistry and Spectroscopy

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Classical Mechanics and Quantum Mechanics** **1.1.** Classical mechanics – *general principles, basic assumptions, postulates of classical mechanics, conservation laws*, D'Alembert's principle, Lagrange's and Hamilton's equations of motion (no derivation). Operators- algebra of operators, commutation relations, commutators, linear, angular momentum, Laplacian, Hermitian, Hamiltonian and Ladder operators, Eigen values and Eigen functions, Hermitian property of operators, orthogonality and normalization. **1.2.** Postulates of quantum mechanics, discussion of the Schrödinger wave equation to simple systems viz., particle in one and three dimensional boxes, quantum numbers, harmonic oscillator-zero-point energy, Bohr's correspondence principle, rigid rotator, rotational and vibrational quantum numbers, hydrogen and hydrogen like atoms (He^+ and Li^{2+}), significance of n, l and m, shapes of atomic orbitals – radial and angular probability distribution functions.	**18**
II	**Application of Quantum Mechanics to Multi Electronic Systems** **2.1.** Approximation Methods- linear variation principle, application to hydrogen and helium atoms, perturbation method for non degenerate systems, application of perturbation theory to helium atom. **2.2**.Two electron systems – symmetric and anti-symmetric wave functions, spin of electrons and Pauli's principles and Slater determinant, self consistent field theory - Hartrees theory, Hartree- Fock theory, Slater type orbitals – Slater rules, orbital energies. **2.3.**Theory of chemical bonding (diatomic molecules), Born-Oppenheimer approximation, LCAO- MO and VB treatments of the hydrogen molecule, Huckel molecular orbital (HMO) theory and its applications to conjugated systems - ethylene, allyl radical and butadiene(linear) principle of hybridization-sp, sp^2 and sp^3.	**18**
III	**Theory of IR and Raman spectroscopy** **3.1.** IR Spectroscopy: Einstein coefficient of absorption and transition probabilities, basics selection rules, representation of spectra, the width and intensity spectral transitions, oscillator strength, *selection rules– harmonic and anharmonic oscillators, hot band, overtones, Fermi resonance, combination bands, rotation* – vibration spectra of diatomic molecules, transition for the rigid rotor, coupling of rotation and vibration– linear and perpendicular bonds, FT-IR spectroscopy, PQR – branches. **3.2.** Raman spectroscopy: Raman effect, elastic and inelastic scattering, selection rules, pure rotational and rotational-vibrational Raman spectra, polarization of light and Raman effect, mutual exclusion principle, Fermi resonance, laser Raman spectroscopy.	**18**
IV	**Theory of NMR-I** **4.1.** Behavior of a bar magnet in a magnetic field, magnetization vectors, resonance condition, relaxation process, Bloch equations, *chemical shift and its measurement*, scalar spin-spin coupling mechanism – nature of the coupling, direct dipolar coupling, NMR in Solids – magic angle spinning, nuclear magnetic resonance imaging (NMRI) – principles and applications. **4.2.** FT-NMR – principle, measurements of T1 by FTS, use of T1 for peak assignment.	**18**

V	**Theory of NMR-II** **5.1**. Second order spectra – introduction, more complicated second order system, *double resonance and spin tickling experiments*, evaluation of thermodynamic data with NMR – rate constants and activation energies, determination of reaction orders by NMR, applications of NMR in kinetic studies. **5.2.** Two dimensional NMR –Theory of 2D NMR (preliminary)	**18**
VI	**Current Trends (For CIA only):** Applications of NMR Spectroscopy in Medical Diagnosis – biomarkers – applications and advantages	

……. Self Study

Text Books:
1. R. K. Prasad, Quantum Chemistry-Through Problems and Solutions, New Age Publications, 2nd Edition, 1997. 2. A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw Hill, 4th Edition, 2010. 3. C. N. Banwell and E. M. Mccash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill Publishing Company Limited, New Delhi, 4th Edition (Indian Edition), 2017. 4. G. M. Barrow, Introduction to Molecular Spectroscopy, Tata McGraw Hill Edition, New Delhi, 1993.
Reference Books:
1. F. L. Pillar, Elementary Quantum Chemistry, Dover Publications, Inc. Mineola, New York, 2nd Edition, 2001. 2. I. N. Levine, Quantum Chemistry, Prentice Hall of India, Pvt. Ltd., 7th Edition, 2016. 3. G. Aruldhas, Molecular Structure and Spectroscopy, PHI learning Pvt. Ltd., New Delhi, 2nd Edition, 2016. 4. R. S. Drago, Physical Methods in Chemistry, East West Press Ltd., Reprint, 1971.
Web Resources:
1. https://archive.nptel.ac.in/courses/104/101/104101124/ 2. https://nptel.ac.in/courses/104101099 3. https://www.youtube.com/watch?v=NF-vc4lqnfg

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember and Understand the concepts of quantum chemistry and spectroscopy	**K1 & K2**
CO2	Apply quantum mechanics in solving SWE to single and much particle system	**K3**
CO3	Differentiate the principles of different spectroscopic techniques	**K4**
CO4	Assess the principles and applications of NMRI, FT-NMR and Solid state NMR	**K5**
CO5	Construct Slater's determinant to molecules and to solve it	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	2	3	3	3	3	3	2.9
CO2	3	3	1	2	1	3	1	2	1	1	1.8
CO3	3	2	2	3	2	3	3	3	1	2	2.4
CO4	3	3	3	3	2	3	3	3	2	2	2.7
CO5	3	1	1	1	1	3	1	1	1	1	1.4
Mean Overall Score											2.24
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. A. Jafar Ahamed

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2CC5	CORE - V	6	6	25	75	100
Course Title	Stereochemistry, Organic Reactions and Steroids						

SYLLABUS		
Unit	Contents	Hours
I	**Stereochemistry- Geometrical Isomers and Conformational Analysis** **1.1. Geometrical Isomers:** *Newman, Sawhorse and Fisher projection formulae and interconversion*. Concept of chirality- Enantiotopic and diastereotopic atoms and groups, prochirality, stereogeneic centre and enantiomeric excess. E-Z nomenclature. Determination of configuration of geometrical isomers. R, S notations of acyclic and cyclic chiral compounds - allenes, spiranes and biphenyl. **1.2. Conformational Analysis:** Conformations- Six-membered Rings containing hetero atoms. Conformation of cyclic compounds 3, 4, 5 & 6 membered rings. Conformational analysis of mono and di substituted cyclohexane and cyclohexanone. Stereochemistry of fused rings-cis and trans decalin, cis and trans hydridanes.	18
II	**Asymmetric synthesis and Dynamic stereochemistry** **2.1 Asymmetric Synthesis** – Basic Principles – stereoselective reduction of cholestan-3-one (Diastereoselectivity), conversion of L-tyrosine into L-DOPA, nucleophilic attack on acyclic chiral carbonyl compounds (Cram's rule – the Felkin – Ahn modification, a diastereoselective synthesis, Use of chiral reagents and chiral catalysts, asymmetric reduction using chiral trialkylboranes asymmetric reduction using lithium aluminium hydride. **2.2. Dynamic stereochemistry:** Quantitative correlations between conformation and reactivity. Weinstein-Eliel equation – Curtin-Hammett principle – Conformation and reactivity of mono and di substituted cyclic systems – Saponification of ester – Esterification of an alcohol – Chromic acid oxidation of cyclohexanol – Neighbouring group participation – De-amination of 2-amino cyclohexanol – Sharpless asymmetric epoxidation – *stereospecific and stereoselective reactions*.	18
III	**Name Reactions and Rearrangements** **3.1. Name reactions: Algar-Flynn-oyamada**, Chichibabin, Darzen's Glycidic ester condensation, Stobbe, *Houben –Hoesch*, Vilmesmier-Haack and Knoevenagal **3.2. Concerted rearrangements:** Cope (including Oxy-Cope) Claisen and Dakin **3.3. Cationic rearrangements:** Beckmann, Pummerer and Schmidt. **3.4. Anionic rearrangements:** Brook, Stevens, Neber, Von Richter, Sommelet – Hauser. **3.5. Aromatic Rearrangement**: Halogen migaration and Hofmann-Martius.	18
IV	**Aromaticity and Heterocyclic Compounds** **4.1. Aromaticity** - Structural features necessary for exhibiting Aromaticity, Benzenoid aromatic compounds, Non-benzenoid aromatic compounds - Heterocyclic compounds - Neutral Large Carboxylic Ring system - Annulenes - Azulene - Fulvalenes, Aromatic cations and Anions –Aromatic Di-cations and Di-anions, Antiaromatic, Non-Aromatic, Homoaromatic and Pseudoaromatic Systems, Frost-Musulin Diagram -Alternant and Non-alternant Hydrocarbons. **4.2. Heterocyclic Compounds**: Nomenclature of heterocyclic compounds, Five membered Heterocyclic compounds with two Hetero atoms-Structure, basicity, properties and preparation-Pyrazole and Oxazole. Six membered Heterocyclic Compounds- structure, basicity, properties and preparation - Quinoline and Acridine.	18

V	**Organic Photochemistry and Pericyclic Reactions** **5.1. Organic Photochemistry and Pericyclic reactions:** Fundamental concepts - Jablonski diagram, photo reduction and photo oxidation, Norrish type I & II reactions, photochemistry of alkenes and dienes, Barton and Paterno - Buchi reaction. **5.2 Pericyclic Reactions:** Features of pericyclic reactions, stereochemistry - orbital symmetry, correlation diagram, Frontier molecular orbital approach for electrocyclic and cyclo addition reactions (4n and 4n+2 Systems). Woodward Hoffman rules, sigmatropic rearrangements - selection rules with simple examples. **5.3. Steroids:** Classification – Structural elucidation and medicinal values of cholesterol (synthesis not required), oestrone and progesterone, stereochemistry of steroids.	18
VI	**Current Trends (For CIA only)** Legal Steroids - Winsol, Clenbutrol.	

……. Self Study

Text Books:

1. D.Nasipuri, Stereochemistry of organic compounds – Principles and Applications, New Age internationals , 2nd Edition, 2002.
2. Ernest L. Eliel, Stereochemistry of organic compounds – principles and Applications, Stereochemistry of Organic Compounds , Wiley, 1st Edition, 2010
3. P.S. Kalsi , Stereochemistry of organic compounds, New Age internationals publishers private Limited , 8th Edition, 2010.
4. B.B. Grill, MR. Willis. Pericyclic reactions, Chapman & Hall, 1974.
5. Gurdeep Chatwal , Organic Chemistry of Natural Products, Himalaya Publishing House, 5th Edition, 2005

Reference Books:

1. F.A. Carey and R.J. Sund berg, Advanced Organic Chemistry, Plenum Publications, Vol.I & II 3rd Edition, 1984.
2. Shukla and G.L Trivedi , Modern Organic Chemistry, Rajendran Ravidra Printers Pvt.Ltd., New Delhi Millinium , 2nd Edition 2000.
3. Rakesh k. parashar, Heterocyclic Chemistry, Ane Books Pvt. Ltd, First Edition 2010.
4. Subrata Sen Gupta, Organic Chemistry, oxford university Press, Second impression 2017.
5. G.R.Chatwal , Reaction and Reagents in Organic Chemistry, Himalaya Publishing House,2019.

Web Resources:

1. https://swayam.gov.in/nd1_noc19_cy25/preview
2. https://onlinecourses.nptel.ac.in/noc21_cy29/preview
3. https://onlinecourses.swayam2.ac.in/cec23_cy03/preview
4. https://www.organic-chemistry.org/namedreactions

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Recall and Understand the concept of stereochemistry	**K1 & K2**
CO2	Apply the concept of stereoselective and enantio selective in asymmetric synthesis.	**K3**
CO3	Discover the mechanism for different types of novel synthetic methods.	**K4**
CO4	Compare the aromatic, anti-aromatic and non-aromatic compounds	**K5**
CO5	Predict the structure and importance of heterocyclic compounds, feasibility of pericyclic reactions and appraise the medicinal properties of steroids.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	2	3	2	3	2	2	3	2.6
CO2	2	3	3	2	3	3	2	3	2	3	2.6
CO3	3	2	3	3	2	3	3	2	3	3	2.7
CO4	2	3	2	3	2	3	2	3	2	3	2.5
CO5	3	2	3	2	3	3	2	3	2	3	2.6
Mean Overall Score											2.6
Correlation											High

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sirajudeen

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Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2CC6	Core - VI	6	6	25	75	100

Course Title	Group Theory and Spectroscopy

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Introduction of Group Theory** **1.1** Symmetry elements and symmetry operations, group - *rules for forming a group*, finite group, infinite group, abelian group, cyclic group, sub groups, group multiplication table- class and similarity transformation. **1.2** Point groups, method of assigning point group- Schoenflies symbols, derivation of matrix form of E, C_n, σ, S_n and i. Reducible and irreducible representations. **1.3** The great orthogonality theorem, properties of irreducible representation, construction of character table for C_2v, C_{2h} and C_3v point groups, explanation of character table, basic idea of correlation table.	**18**
II	**Applications of Group Theory –I** **2.1** The direct product and its applications, applications of group theory to spectroscopy - vanishing of integrals, symmetry selection rules for vibrational, Raman and electronic spectroscopy. **2.2** Reduction Formula and its applications, determination of symmetries of vibrational modes and their IR and Raman activities in non-linear molecules (H_2O and NH_3) and linear molecules (CO_2 and C_2H_2) sub group and Integration method, *mutual exclusion rule*, electronic transitions in formaldehyde and ethylene using group theory.	**18**
III	**Applications of Group Theory –II** **3.1** Applications of Group theory: Hybridization schemes for atoms in molecules of different geometry – tetrahedral (CH_4), triangular (BF_3) planar linear (C_2H_2) and non-linear (C_2H_4) molecules. **3.2** Symmetry in crystals: Hermann - Mauguin symbols, *space groups of crystals*, differences between point group and space group, translational elements of symmetry- glide plane and screw axis, comparison of crystal symmetry with molecular symmetry. **3.3** Projection Operator: Symmetry Adapted Linear Combination (SALC) procedure. Symmetry factors of secular determinant and its applications to butadiene.	**18**
IV	**Theory of IR and Raman Spectroscopy** **4.1** IR Spectroscopy: Theory of rotational-vibrational spectra – Hooke's law, harmonic and anharmonic oscillators, hot bands, overtones, Fermi resonance, combination bands, force constant, effect of isotopic substitution on vibrational frequencies, coupling of rotation and vibration-linear and perpendicular bands, PQR branches. (Problems from Hooke's law and force constant) **4.2** Raman Spectroscopy: *polarization of light and Raman effect– elastic and inelastic scattering*, pure rotational and rotational-Vibrational Raman spectra. Lasers- special properties and principles of working. Laser Raman spectroscopy, Resonance Raman spectroscopy and surface enhanced Raman scattering-theory and advantages.	**18**

V	**Theory of NMR Spectroscopy** **5.1** NMR Spectroscopy: theory- behaviour of a bar magnet in a magnetic field, *magnetization vectors*, resonance conditions, relaxation processes in NMR – spin-spin, spin-lattice and quadrupole relaxations, effect of quadrupole nuclei on relaxation mechanism, Bloch equations (no derivation), chemical shift and its measurements- δ and τ scales. **5.2** Spin - Spin Coupling: mechanism of coupling, nature of the coupling- scalar and direct dipolar coupling, NMR in solids- principle, magic angle spinning technique, applications and advantages. Principle and applications of nuclear magnetic resonance imaging (NMRI). **5.3.** FT-NMR- principle, instrumentation and applications, advantages of FT-NMR over continuous wave NMR. Theory, types and advantages of 2D-NMR.	**18**
VI	**Current Trends (For CIA only)** Electro Magnetic Acoustic (EMA) imaging – principle, applications and advantages, comparison of NMRI and EMA techniques.	

……. Self Study

Text Books:

1. K.V. Raman , Group theory and its Application to Chemistry, Tata McGraw Hill Publishing Company Limited, New Delhi, 1st Edition, 2002.
2. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Publishers, New Delhi, Reprint, 2010.
3. C. N. Banwell and E. M. Mccash, Fundamentals of Molecular Spectroscopy, Tata McGraw Hill Publishing Company Limited, New Delhi, 4th Edition (Indian Edition), 2017.
4. G. M. Barrow, Introduction to Molecular Spectroscopy, Tata McGraw Hill, Indian Edition, New Delhi, Revised Edition, 1993.

Reference Books:

1. F. A. Cotton, Chemical Application of Group Theory, Wiley Eastern Press, Texas, 3rd Edition, 2003.
2. G. Aruldhas, Molecular Structure and Spectroscopy, PHI learning Pvt. Ltd., New Delhi, 2nd Edition, 2016.
3. R. S. Drago, Physical Methods in Chemistry, East West Press Ltd., Reprint, 1971.
4. Manas Chanda, Structure and Chemical Bonding including Molecular Spectra, Tata McGraw Hill Publishing Company Ltd., New Delhi, Reprint, 2000.

Web Resources:

1. https://archive.nptel.ac.in/courses/104/104/104104080/
2. https://www.youtube.com/watch?v=NF-vc4lqnfg
3. https://nptel.ac.in/courses/104101099

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember and understand the concepts of group theory and spectroscopy	**K1 & K2**
CO2	Apply the theory of IR and Raman spectroscopy in group theory	**K3**
CO3	Differentiate molecular symmetry and crystallographic symmetry	**K4**
CO4	Analyze the IR, Raman and NMR spectra of molecules	**K5**
CO5	Construct the character tables of different point groups	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**2.6**
CO2	**3**	**3**	**3**	**2**	**1**	**3**	**3**	**3**	**2**	**2**	**2.5**
CO3	**3**	**2**	**2**	**1**	**1**	**3**	**1**	**1**	**2**	**1**	**1.7**
CO4	**3**	**3**	**3**	**2**	**1**	**3**	**2**	**3**	**1**	**2**	**2.1**
CO5	**3**	**2**	**1**	**1**	**1**	**3**	**1**	**2**	**1**	**1**	**1.6**
Mean Overall Score											**2.1**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. M. Anwar Sathiq

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2CC7P	Core – VII	6	4	20	80	100

Course Title	Inorganic Qualitative Analysis and Colorimetric Estimations – Practical

SYLLABUS

Contents	Hours
List of Practicals: **I. Semi-micro Qualitative Analysis: -50 Marks** Analysis of two common and two rare earth elements in a given inorganic mixture: **1. Common:** Pb, Cu, Bi, Cd, Zn, Co, Ni, Ca, Ba, Sr **2. Rare:** W, Se, Te, Mo, Ce, Zr, Th, V, Li **II. Colorimetric Estimations: -25 Marks** **Cu, Fe, Mn, Ni and Cr** **III. Viva-Voce -05 Marks** **Scheme of Valuation:** Procedure Writing - 10 Marks **For Analysis:** 4 radicals correct with suitable tests: 40 marks 3 radicals correct with suitable tests: 30 marks 2 radicals correct with suitable tests: 20 marks 1 radical correct with suitable tests: 10 marks **For Colorimetric Estimations:** 1-2% - 25 marks 2-3% - 20 marks 3-4% - 15 marks >4% - 10 marks	**90**

Text Books:

1. Vogel A I, A Text Book of Quantitative Inorganic Analysis, 3rd Edition, Longman Group,1972

Reference Book(s):

1. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis, The National Publishing Company, Chennai, 3rd edition,1974.

Web Resources:
1. https://www.youtube.com/watch?v=6O81ArjA5SM 2.http://www.rbmcollege.ac.in/sites/default/files/files/reading%20material/inorganic-qualitative-analysis.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Understand the principle semi micro qualitative analysis and photo colorimetric estimation	**K1& K2**
CO2	Apply the concept of solubility product, ionic product and common ion effect in the separation of metal ion based on group	**K3**
CO3	Differentiate rare and common cations	**K4**
CO4	Estimate the quantity of metal ions present in a solution in trace amount	**K5**
CO5	Appraise the principle of photo colorimetry in food product analysis	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.6**
CO2	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**2**	**2**	**2**	**2.5**
CO3	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**2.5**
CO4	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**1**	**3**	**2**	**2.5**
CO5	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2.7**
										Mean Overall Score	**2.56**
										Correlation	**High**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. A. Asrar Ahamed

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2CC8P	Core - VIII	6	4	20	80	100
Course Title	Qualitative Analysis of Organic Mixture and Chromatography Techniques - Practical						

SYLLABUS	
Contents	**Hours**
Identification of components in a two component mixture – 55 Marks **Separate the following types of mixture:** (a) soluble & insoluble (b) acidic & neutral (c) less acidic and neutral and (d) basic & neutral (both Pilot and Bulk) and analyze any one of the components present as instructed by the Teacher / Examiner. **The components to be reported are:** 1. Pilot separation 2. Special elements present/absent 3. Aromatic/aliphatic 4. Saturated/unsaturated 5. Functional group present 6. Suitable solid derivative **Chromatographic Technique –20 Marks** Separation of amino acids mixture by Thin Layer Chromatography **Viva-Voce – 05 Marks** **<u>Scheme of Evaluation</u>** **Organic Analysis - 55 Marks** Procedure Writing - 10 marks Pilot separation - 10 marks Special elements present / absent - 07 marks Aromatic/ aliphatic - 07 marks Saturated/ unsaturated - 07 marks Functional group present - 07 marks Derivative - 07 marks **Chromatographic Technique - 20 Marks**	**90**

Text Books:
1. V K Ahluwalia & Sunita Dhingra, Comprehensive Practical Organic Chemistry Qualitative Analysis, Universities Press, Orient Longman, 1st Edition, 2000. 2. Arthur I. Vogel, Elementary Practical Organic Chemistry, Pearson, 1st Edition, 2011.
Reference Books:
1. Arthur I. Vogel, A Text Book of Practical Organic Analysis, Longman, 5th Edition, 1989 2. H.T. Openshaw, A Laboratory Manual of Qualitative Organic Analysis, Cambridge University Press, 3rd Edition, 1976.
Web Resources:
1. https://www.csub.edu/chemistry/organic/manual/Lab14_QualitativeAnalysis.pdf 2. https://edu.rsc.org/download?ac=520321

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Classify acidic, basic, phenolic and neutral substances	**K1 & K2**
CO2	Analyse the functional groups present in the organic compounds	**K3**
CO3	Separate the mixtures of organic compounds	**K4**
CO4	Assess the R_f value and polarity of organic compounds	**K5**
CO5	Manage variety of reagents and solvents employed for the analysis	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**3**	3	**2**	**2**	**2**	**3**	2	**3**	**2**	**2**	**2.4**
CO2	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2.4**
CO3	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2.3**
CO4	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.1**
CO5	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.1**
										Mean Overall Score	**2.26**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. F.M. Mashood Ahamed

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2DE2A	Discipline Specific Elective-II	6	4	25	75	100

Course Title	Organometallics and Inorganic Spectroscopy

SYLLABUS

Unit	Contents	Hours
I	**Reactivity and Stability of coordination compounds** **1.1 Reactivity of Complexes in solutions** – Labile and inert complexes. Ligand displacement reactions – hydrolysis reactions - acid, base and anation in Oh complexes. Electron Transfer Reactions - inner and outer sphere processes. complementary and non-complementary reactions. Ligand substitution in square planar complexes - Trans effect, Theory - π-bonding theory, electrostatic polarization theory and applications. Template effect. **1.2 Stability of coordination compounds:** Detection of complex formation in solution - stability constants, stepwise, overall formation constants, determination by pH-metric, polarographic and *photometric methods*. Factors affecting stability of complexes – properties of central metal ion and ligand.	18
II	**Complexes of π-acceptor and π-donor ligands** **2.1 π-acceptor ligands** – 18 electron rule – counting of electrons and finding metal-metal bonds, structural study of poly nuclear carbonyls ($Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$). Carbonylate anions, carbonyl hydrides, isolobal fragments. Nitrosyl complexes – Preparation and structure of bridging and terminal nitrosyls, bent and linear nitrosyls. Dinitrogen and dioxygen complexes – Preparation and structure. **2.2 π-donor ligands:** Alkene (Zeise's salt), alkyne and allyl complexes - Synthesis, structure and bonding. Metallocenes – *Ferrocene* and nickelocene - preparation, properties and structure - Molecular orbital concept. Piano stool complexes – structures only	18
III	**Organometallic reactions and Metallobiomolecules** **3.1 Organometallic Chemistry:** Ligand association and dissociation – oxidative addition – Concerted, S_N2 and radical mechanisms; reductive elimination, α and β migratory insertion & elimination reactions. Catalysis by Organometallics - Hydrogenation, hydroformylation, polymerisation of alkenes, olefin oxidation (Wacker Process), Fischer–Tropsch synthesis and olefin metathesis. **3.2 Metallobiomolecules:** Oxygen carriers - Hemoglobin and myoglobin – Structure and functions – oxygen affinity, cooperativity and Bohr effect. Electron carriers – cytochrome-c; copper proteins. Oxido-reductases - Ferredoxins and rubredoxins, superoxide dismutase. *Urease and hydrogenases – structure and functions*.	18
IV	**Electronic spectroscopy:** Electronic configuration - Terms, states and microstates of atoms and ions – Derivation of term symbols d^n and arranging the various term according to their energies - spectroscopic terms – L-S coupling and jj coupling – *Racah parameters B and C – selection rules and the breakdown of selection rules – mixing of orbitals*. Orgel diagram – characteristics, prediction and assignment of transitions for d^n weak field systems, band intensity, band width, band shape, calculation of β and 10 Dq for simple octahedral complexes of Co and Ni. Tanabe-Sugano diagrams – prediction and assignment of transitions for weak field and strong field of d^n systems. Charge transfer spectra - LMCT and MLCT	18

V	**IR and Raman spectroscopy:** Combined uses of IR and Raman spectroscopy in the structural elucidation of N_2O, H_2O, ClF_3, NO_3^- and ClO_3^-. Effect of coordination on ligand vibrations. Uses of group vibrations in the structural elucidation of metal complexes of urea, cyanide, nitrate and sulphate. Effect of isotopic substitution on vibrational spectra of metal carbonyls. **Mossbauer Spectroscopy:** Mossbauer transition and Doppler Effect - isomer Shift, quadrupole effect – application to iron and tin compounds. **Lanthanides and Actinides:** Co-ordination compounds of lanthanides and actinides, spectral and magnetic properties. *Synthesis of transuranic elements*.	**18**
VI	**Current Trends (For CIA only)** Applications of organometallic compounds in medicine – Ferroquine as antimalarial, ferrocifen as breast cancer drug.	

……. Self Study

Textbooks:

1. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, Revised 1st edition, Vikas PublishingHouse Pvt. Ltd., New Delhi, 2008.
2. B.D.Gupta,A.J.Elias, Basic OrganometallicChemistry- Concepts, Syntheses andApplications, University Press, Hyderabad, Reprint Edition, 2011
3. R.C.Mehrotra, A.Singh, Organometallic Chemistry-A Unified Approach, Revised 2nd Edition, New Age International Publishers, 2011
4. Satya Prakash, G.D.Tuli, S.K.Basu, R.D.Madan, Advanced Inorganic Chemistry Vol-I, 19th Edition, S.Chand & Co., Ltd., New Delhi, 2011

Reference Books:

1. Cotton and Wilkinson Advanced Inorganic Chemistry 6th Edition John Wiley & Sons, New York 2004
2. James E. Huheey, Ellen A. Keiter and Richard L. Keiter Inorganic Chemistry Principles of Structure and Reactivity 4th Edition Pearson Education,11th Impression, 2011
3. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, New York, 6th Edition, 2000.
4. W.Kaim and B. Schewederski, Bioinorganic Chemistry: InorganicElements in the Chemistry of Life, 2nd Edition, John Wiley & Sons, New York,USA, 2001
5. P. Powell. Principles of Organometallic Chemistry, 2nd Edition, Chapman andHall, London, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc20_cy12/preview
2. https://nptel.ac.in/courses/104105033
3. https://nptel.ac.in/courses/104101116

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Examine the stability of complexes, describe the organometallic compounds and the role of metals in bio molecules	**K1 & K2**
CO2	Interpret the structure of the coordination compounds and inorganic molecules by electronic, IR, Raman and Mossbauer spectral studies	**K3**
CO3	Categorize the type of organometallic reactions	**K4**
CO4	Summarise the reactivity, stability of coordination compounds and conclude the vital role of metals in biological studies	**K5**
CO5	Infer the role of organometallic compounds as catalysts and adapt the inorganic complexes using spectral studies.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.4**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2.6**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.9**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2.8**
Mean Overall Score											**2.7**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. Loganathan

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PCH2DE2B	Discipline Specific Elective-II	6	4	25	75	100

Course Title	Chemistry of Inorganic Complexes

SYLLABUS

Unit	Contents	Hours
I	**Reactivity and Stability of coordination compounds** **1.1 Reactivity of Complexes in solutions** – Labile and inert complexes. Ligand displacement reactions – hydrolysis reactions - acid, base and anation in octahedral complexes. Electron Transfer Reactions - inner and outer sphere processes. complementary and non-complementary reactions. Ligand substitution in square planar complexes - *Trans effect*, Theory - π-bonding theory, electrostatic polarization theory and applications. Template effect. **1.2 Stability of coordination compounds:** Detection of complex formation in solution - stability constants, stepwise, overall formation constants, determination by pH-metric, polarographic and photometric methods. Factors affecting stability of complexes – properties of central metal ion and ligand.	18
II	**Organometallic Chemistry** **2.1 Metal Clusters:** Definition – Dinuclear and Multinuclear metal carbonyl clusters, low and high nuclearity carbonyl clusters – electron counting. Capping rule and Mingo rule, carbide clusters. The isolobal analogy. Synthesis and reactions of metal carbonyl clusters **2.2 Reactions in Organometallic Chemistry:** Ligand association and dissociation – oxidative addition - Intramolecular oxidative addition, oxidative coupling. Reductive elimination - mononuclear and binuclear systems. Migratory insertion reactions – migration Vs insertions, insertions of alkenes, β-hydrogen elimination Vs reductive elimination.	18
III	**Catalysis by Organometallics**: 3.1 Hydrogenation catalysts – classification, Wilkinson's catalyst, Schrock-Osborn's catalyst, Crabtree's catalyst, Marks' catalyst. Catalytic asymmetric hydrogenation – mechanism. Hydrocyanation of alkenes, Hydrosilylation of alkenes. 3.2 Hydroformylation – Importance, cobalt catalyst, phosphine modified cobalt catalyst, rhodium-phosphine catalysts, factors affecting *n/iso* ratio of hydroformylation products. Methanol carbonylation and olefin oxidation – Monsanto process, Cativa process, *Wacker's process*. 3.3 Olefin metathesis – Mechanism – ring opening metathesis, cross metathesis, ring closing metathesis, ring opening methathesis polymerization, acyclic diene metathesis polymerization, enyne methathesis; applications of metathesis.	18
IV	**IR, Raman and Mossbauer spectroscopy:** 4.1 Combined use of IR and Raman spectroscopy in the structural elucidation of N_2O, H_2O, ClF_3, NO_3^-, ClO^- Effect of coordination on ligand vibrations – uses of group vibrations in the structural elucidation of metal complexes of urea, cyanide, nitrate and sulphate – Effect of isotopic substitution on the vibrational spectra of molecules – *vibrational spectra of metal complexes*. **4.2 Mossbauer Spectroscopy:** Principle, Line width – Collision broadening, Doppler broadening, Heisenberg's uncertainty principle. Conditions for MB spectroscopy, Mossbauer spectrometer, Isomer shift, Mossbauer transition and Doppler Effect – nuclear quadrupole interaction, magnetic hyperfine interactions, applications – $Fe[Fe(CN)_6]$, $Fe(CO)_5$, $Fe_3(CO)_{12}$, $FeSO_4.7H_2O$, $FeCl_3$, $K_4Fe(CN)_6]$, $K_3[Fe(CN)_6]$ and $Na_2[Fe(CN)_5NO]$.	18

V	**Electronic spectroscopy:** 5.1 Electronic configuration - Terms, states and microstates of atoms and ions – Derivation term symbols (p^2 and d^2) and arranging the various termaccording to their energies spectroscopic terms – L-S coupling and JJ coupling – *effect of interelectronic repulsion and spin-orbit coupling* – Racah parameters B and C – selectionrules and the breakdown of selection rules – mixing of orbitals. 5.2 Orgel diagram – characteristics – prediction and assignment of transitions for d^n weak field systems. Tanabe – Sugano diagrams – prediction and assignment of transitions for weak field and strong field – d^n systems band intensity, band widths-band shapes - calculation of β and 10 Dq for simple octahedral complexes of Co and Ni-charge transfer spectra.	**18**
VI	**Current Trends (For CIA only) –** Applications of organometallic compounds in industries and medicine.	

……. Self Study

Textbooks:

1. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, Revised 1st Edition, Vikas PublishingHouse Pvt. Ltd., New Delhi, 2008.
2. B.D. Gupta, A.J.Elias, Basic Organometallic Chemistry- Concepts, Syntheses andApplications, University Press, Hyderabad, Reprint Edition, 2011
3. R.C. Mehrotra, A.Singh, Organometallic Chemistry-A Unified Approach, Revised 2nd Edition, New Age International Publishers, 2011
4. Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, Advanced Inorganic Chemistry Vol-I, 19th Edition, S.Chand & Co., Ltd., New Delhi, 2011
5. Gurdeep Raj, Advanced Inorganic Chemistry-Vol.-I, 32nd Edition, Krishna's Educational Publishers, 2014.

Reference Books:

1. James E. Huheey, Ellen A. Keiter and Richard L.Keiter, Inorganic Chemistry Principles of Structure and Reactivity 4th Edition Pearson Education,11th Impression, 2011
2. Cotton and Wilkinson, Advanced Inorganic Chemistry 6th Edition John Wiley & Sons, New York, 2004
3. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, New York, 6th Edition, 2000.
4. W. Kaim and B. Schewederski, Bioinorganic Chemistry: InorganicElements in the Chemistry of Life, 2nd Edition, John Wiley & Sons, New York,USA, 2013
5. P. Powell. Principles of Organometallic Chemistry, 2nd Edition, Chapman andHall, London, 2003

Web Resources:

1. https://nptel.ac.in/courses/104105033
2. https://nptel.ac.in/courses/104101116
3. https://nptel.ac.in/courses/104108062
4. https://nptel.ac.in/courses/104101091

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Examine the reactivity and stability of coordination compounds, describe the reactions and catalysis of organometallic compounds	**K1 & K2**
CO2	Interpret the structure of the coordination compounds and inorganic molecules by electronic, IR, Raman and Mossbauer spectral studies	**K3**
CO3	Differentiate various catalysts used in hydrogenation and hydroformylation reactions	**K4**
CO4	Summarise the catalytic loop by various organometallic reactions	**K5**
CO5	Develop a new organometallic catalyst	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.4**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2.6**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.9**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2.8**
Mean Overall Score											**2.7**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. N. Mujafarkani

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3CC9	Core - IX	6	6	25	75	100

Course Title	Resonance, Photoelectron Spectroscopy of Inorganic Compounds and Bio-Medicinal Chemistry

SYLLABUS

Unit	Contents	Hours
I	**NMR and PES** 1.1 **NMR Spectroscopy**: Principle, *splitting of nuclear magnetic energy levels chemical shift, spin - spin coupling*, coupling constant - one bond coupling, two bond coupling, long range coupling; ^{1}H NMR spectra - SiH_3SiCl_2H, PF_2H, SiH_3PH_2, BH_4^-, HD, $HRh(CN)_5^{3-}$; ^{13}C NMR spectra - $Cr(CO)_6$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Co_2(CO)_8$; ^{31}P NMR spectra- HPF_2, H_3PO_2, H_3PO_3, H_3PO_4, P_4S_3, $HP_2O_5^{3-}$, $Rh(PPh_3)_3Cl_3$; ^{19}F NMR spectra - ClF_3, ClF_5, BrF_5, PF_5. 1.2 Effect of quadrupolar nuclei on the NMR spectrum- $^{14}NH_3$, $^{15}NH_3$, $^{14}NH_4^+$; NMR of paramagnetic molecules - isotopic shifts, contact and pseudocontact shifts, Lanthanide shift reagents, fluxional behaviour of molecules in NMR. 1.3 **Photoelectron spectroscopy:** Principle, types - UPES, XPES. Koopman's theorem, PES of H_2, N_2 and CO. Auger electron spectroscopy- Auger effect, applications of PES.	18
II	**ESR, Magnetism and Photochemistry of Complexes** 2.1 **ESR Spectroscopy:** Principle, presentation of spectrum, hyperfine coupling, isotropic and anisotropic hyperfine coupling constants, Mc-Connell equation- calculation of unpaired electron density. g value in esr spectroscopy – g values of transition metal ions – dependence of spin-orbit coupling and crystal field effects; zero field splitting and Kramer's degeneracy, EPR spectra of transition metal complexes - d^1 (VO^{2+}, Ti^{3+}), d^3(Cr^{3+}) d^5 (Mn^{2+}, Fe^{3+}), d^7(Co^{2+}), d^9 (Cu^{2+})-bis(salicylaldiminecopper(II)). 2.2 **Magnetic properties:** Origin of magnetism - orbital magnetic moment, spin magnetic moment - *Types of magnetism - dia, para, ferro* ferri, and antiferro magnetism, hysteresis - magnetic properties of free ions - first and second order Zeeman effects. 2.3 **Photochemistry of coordination compounds:** Introduction- Photo redox reactions –inner sphere mechanism, outer sphere mechanism and decomposition. Photoisomerisation- geometrical, optical, racemisation reaction; Photo substitution reactions.	18
III	**Solid State** 3.1 **Crystalline solids:** Unit cell, crystal symmetry, symmetry elements, crystal systems, Bravais lattices, space group, translational elements of symmetry- screw axis, glide plane. equivalent positions, relationship between molecular symmetry and crystallographic symmetry. 3.2 **Crystal Growth methods:** Conditions for growing crystal, Classification of Crystal growth methods- growth from melt - Bridgmann method, pulling method; growth from solution - *Hydrothermal growth, Gel growth methods* 3.3 **Diffraction Studies:** X-ray diffraction by rotating crystal method. Neutron diffraction study - elementary treatment, comparison with X-ray diffraction. Electron diffraction studies- principle and applications. 3.4 **Electron microscopy**: Differences between optical and electron microscopy- principle and applications of SEM and TEM. Comparison of SEM and TEM.	18

IV	**Bioinorganic Chemistry and Metal clusters** 4.1 **Metals at the centre of photosynthesis:** Primary processes in photosynthesis- Photosystems - I and II – Light absorption (Energy Acquisition)-Exciton transport (Direct Energy Transfer) - *Charge separation and electron transport - Manganese catalysed oxidation of water to molecular oxygen*. 4.2 **Biological Functions of alkali and alkaline-earth metals:** K^+, Na^+, Ca^{2+} and Mg^2, Macro cyclic ligands – characteristics, structure and applications of crown ethers, cryptands and spherands. Ion Channels- ionophores and ion transporters, Na^+ - K^+ Pump – mode of action and biological functions. 4.3 **Metal Clusters and Polyacids:** Metal cluster- definition, classification-preparation, properties, structure and bonding of $Re_2Cl_8^{2-}$. Polyacids – iso and heteropolyacids of Mo and W – Structure, Keggin's theory.	**18**
V	**Medicinal Bioinorganic Chemistry** 5.1 **Bioinorganic Chemistry of quintessentially toxic metals:** Toxicity of Lead, Cadmium, Mercury, Chromium, Copper, Arsenic and Antimony. Detoxification by metal chelation – mode of action and structure of Penicillamine, Dimercaprol, Dimercapto succinic acid, Calcium disodium edetate and Desferrioxamine. 5.2 **Metals in medicine:** Platinum complexes in cancer therapy- synthesis, properties, structure, mode of action, applications, advantages and side effects of cis-platin. Antirheumatic agents - Gold compounds and their mode of action. Pschycopharmocological drugs -Lithium carbonate, Diabetic drugs – vanadium compounds. 5.3 **Radiopharmaceuticals:** Technetium, Gadolinium, Iodine, Cobalt, *Radium and Sodium* in radiotherapy.	**18**
VI	**Current Trends (For CIA only)** Recent trends of radiopharmaceuticals for cancer treatment- Lu^{177} and Y^{90}	

…..... Self Study

Text Books:

1. E.A.V. Ebsworth, W. H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, 2nd Edition, ELBS, 1991.
2. A. Abdul Jameel, Application of Physical Methods to Inorganic Compounds, 4th Edition, Jan Publications, Tiruchirappalli, 2019.
3. H. Kaur, Spectroscopy, 17thEdition, Pragati Prakasan Publications, Meerut, 2023.
4. James E. Huheey, Ellen A. Keiter, Richard L. Keiter and Okhil K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, Pearson Education House, 2011.
5. Stephen J. Lippard and Jeremy M. Berg, Principles of Bioinorganic Chemistry, 1stEdition, University Science Books, Millvelley, California, 1994.

Reference Books:

1. P. K. Ghosh, Introduction to Photoelectron Spectroscopy, John Wiley, New York, USA, 1989.
2. R.S. Drago, Physical Methods in Inorganic Chemistry, International Students Edition, Reinhold Publishing Corporation, New York, 2010.
3. Anthony P. West, Solid state Chemistry and its applications, 2ndEdition, John Wiley, New York, 2022.
4. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the chemistry of life-An Introduction and Guide, 2nd Edition, John Wiley & Sons, New York, USA, 2013.
5. J. P. Glusker and K. N. Trueblood, Crystal Structure Analysis: A Primer, 3rdEdition, Oxford University Press, UK, 2010.

Web Resource(s):

1. https://archive.nptel.ac.in/courses/104/106/104106048/
2. https://www.youtube.com/watch?v=N_U9NoiiaYI
3. https://archive.nptel.ac.in/courses/104/101/104101116/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Understand the role of metal ions in biological functions	**K1 & K2**
CO2	Apply ESR spectroscopy to investigate the inorganic materials	**K3**
CO3	Compare para, dia, ferro and anti-ferro magnetisms.	**K4**
CO4	Evaluate the structure of inorganic compounds by NMR, X-ray diffraction and photoelectron spectroscopy	**K5**
CO5	Formulate the suitable detoxification drugs for heavy metal poisoning	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2.6**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2.7**
CO4	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2.8**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.9**
Mean Overall Score											**2.76**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. **Dr. K. Loganathan**
2. **Dr. M. Anwar Sathiq**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3CC10	Core - X	6	6	25	75	100

Course Title	ORGANIC SPECTROSCOPY AND PERICYCLIC REACTIONS

SYLLABUS

Unit	Contents	Hours
I	**UV-VISIBLE AND INFRARED SPECTROSCOPY** **1.1** *Basic principles of electronic transitions –Selection rules, correlation of energy change with electronic transitions, chromophore and Auxochrome concept - designation of UV bands, factors affecting Absoption bands. Applications of UV–Visible spectroscopy* Franck-Condon principle - Woodward - Fieser - Scott rules - Applications to conjugated dienes, trienes, polyenes, α, β-unsaturated carbonyl compounds, conjugated cyclic ketones and acetophenones, benzene and its derivatives, Stereochemical factors affecting electronic spectra of biphenyl and binaphthyl, cis and trans isomers – angular distortion and cross conjugation, charge transfer spectra. **1.2 Infrared Spectroscopy:** Basic principle, types of vibrations - Fermi resonance. Finger print region, factors affecting IR frequency - characteristics group frequencies, presentation and interpretation of IR spectrum, – hydrogen bonding (intermolecular and intramolecular) - conformational aspects in cyclic 1,2- diols and 1,3- diols, trans annular interaction in UV and IR Determination of reaction rates and mechanisms of reactions employing IR and UV spectroscopy(basic aspects).	**18**
II	**PROTON NMR SPECTROSCOPY** 2.1 Theory of NMR- Chemical and magnetic equivalence, non-equivalence, relaxation process, chemical shift - internal standard and solvents - factors influencing chemical shift – peak area, proton count, number of signals, splitting of signals, coupling constant - dependence of J on dihedral angle, vicinal and geminal coupling, Karplus equation, Long range coupling, restricted rotation around C-N bond. 2.2 First order and non-first order spectra, - simplification of complex spectra - double resonance technique, high field strength and lanthanide shift reagents. Chemical spin decoupling of rapid exchangeable protons (OH, SH, COOH, NH_2) ***Variable temperature spectra***. Nuclear Overhauser Effect (NOE). 2.3 Instrumentaion, Theory of Continuous wave (CW) NMR and Fourier Transform (FT) NMR. NMR spectrum of n- propanol, benzaldehyde, *p*-nitrobenzaldehyde, aniline, *p*-toluidine, *m*-cresol and phenyacetylene molecules. Magnetic Resonance Imaging(MRI-scan).	**18**
III	**^{13}C NMR, 2D NMR and ESR SPECTROSCOPY** 3.1. ^{13}C- NMR: Principle, comparison of ^{13}C- NMR and ^{1}H NMR, Chemical shift, simplification of ^{13}C- NMR - broad band decoupling and off-resonance decoupling. α, β and γ - effect of substituents (Straight and branched chain alkanes) and effect of hybridization. Calculation of chemical shifts for simple aliphatic and aromatic compounds.), DEPT spectra. 3.2. 2D NMR: Principle of 2D NMR, COSY (H-H and H-C) spectrum of Nitrotoluene and 1,3-dinitrobenzene, NOSEY and ***ROSY***. 3.3. Electron spin resonance spectroscopy: Basic principle - comparison between ESR and NMR spectra, hyperfine splitting - factors affecting the magnitude of g values. Applications to $^{\bullet}CH_3$, $^{\bullet}CH_2D$, $^{\bullet}CD_3$, benzene, naphthalene and benzoquinone anion radicals.	**18**

IV	**MASS SPECTROSCOPY and ORD & CD** 4.1 Mass Spectroscopy: *Basic principle, parent ion peak, base peak, isotopic peak, metastable peak and its importance*, modes of ionization – EI, CI, FAB and ESI, HRMS and TOF -recognition of molecularion peak and isotopic peak - determination of molecular formula - nitrogen rule – DBE. Fragmentation pattern for compounds containing CH_3, OH, CHO, COOH and NH_2, Mc Lafferty rearrangement. 4.2 Optical rotatory dispersion and circular dichroism: Theory and terminology. Cotton effects and ORD curves, Axial haloketone rule and octant rule- applications 4.3 Combined spectral problem of organic compounds (UV, IR, ^1H, ^{13}C NMR and Mass).	**18**
V	**Pericyclic Reactions and Natural Products** **5.1. Advanced Pericyclic reactions**: Sigmatropic rearrangement [3,3] shift: Cope, oxy Cope, anionic Cope rearrangements, Claisen, Eschenmoser-Claisen, Johnson-ortho ester Claisen, Ireland-Claisen rearrangements, [2,3] shift: Sommelet-Hauser, Wittig rearrangements. Cyclo addition: Diels-Alder reaction- HOMO-LUMO energy gap of diene-dienophile, Alder's endo rule, 1,3-Dipolar cycloaddition, **5.2. Polysaccharides:** Homo polysaccharides - structure and properties of starch, glycogen, cellulose,chitin and inulin. Hetero polysaccharides - heparin, chondroitin and hyaluronic acid-structure and properties. **5.3. Lipids:** Classification, structure, biological importance of lipids. Fatty acids-Classification- saturated, unsaturated, hydroxy, cyclic, essential and non-essential fatty acids, functions of fatty acids.	**18**
VI	**Current Trends (For CIA only)** **HSQC & HMBC NMR Spectra**: HSQC - H-C single bond correlation, HMBC - correlation for ^1H resonance and ^{13}C resonance that are either 2, 3 or 4 bonds away.	

…..... Self Study

Text Book(s):

1. Y.R. Sharma, Elementary Organic Spectroscopy: Principles and Chemical Applications, 1st Edition, S.Chand Publications,New Delhi, 2012
2. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of Organic compounds, 6th Edition, John Wiley & Sons, India, 2006.
3. P.S.Kalsi, Spectroscopy of Organic Compounds, 6th Edition, New Age international Publishers, India, 2004
4. Q.N. Porter and J.Baldas, Mass Spectrometry of Heterocylic compounds,1st Edition, John Wiley & Sons, New Delhi,1971.
5. N. J. Turro, V. Ramamurthy and J. C. Scaiano, Modern molecular photochemistry of organic compounds, University Science Books, 2010.
6. I.L. Finar, Organic Chemistry,Vol. II, 5th Edition, ELBS, 1975.

Reference Book(s):

1. Willam Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, New York, 1991.
2. J.R. Dyer, Application of Absorption spectroscopy of organic compounds, 1st Edition, Prentice Hall, US, 1965
3. Dudley H.Williams, Ian Fleming, Spectroscopic Methods In Organic Chemistry, 6th Edition, McGraw-Hill-Education-Europe, 2011
4. Jag Mohan, Organic Spectroscopy: Principles andApplications, 2nd Edition, Alpha Sciences International Ltd, India, 2002
5. S. Sankararaman, Pericyclic Reactions – A textbook. Wiley-VCH, 2005.
6. Grudeep Chatwal, Organic Chemistry of Natural Products Vol.II, 3rd Edition, Reprint, Himalaya Publishing House, India, 2000.

Web Resource(s):

1. https://www.youtube.com/watch?v=m33OeLsp8o0
2. https://www.youtube.com/watch?v=EnB7aw7lGxg
3. http://www.digimat.in/nptel/courses/video/104108124/L01.html
4. https://youtu.be/cVtotaa9J4U?si=wUNWHvlxbgO0LHmw
5. https://onlinecourses.nptel.ac.in/noc20_cy15/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse the nature of organic compounds based on the Electronic and vibrational transitions.	**K1 & K2**
CO2	Predict the Chemical environment of the protons of organic compounds based on its chemicalshift values.	**K3**
CO3	Analyse the stereo chemical orientation of molecules using correlation spectroscopy.	**K4**
CO4	Solve the molecular structure of organic compounds by combined spectral data.	**K5**
CO5	Generate a plausible reaction pathway of pericyclic reactions.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**2**	3	**3**	**2**	**3**	**1**	**3**	**2**	**3**	**3**	**2.5**
CO2	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**1**	**1**	**1.9**
CO3	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**1**	**2**	**3**	**1.9**
CO4	**3**	**2**	**1**	**1**	**2**	**3**	**2**	**1**	**1**	**1**	**1.7**
CO5	**3**	**1**	**1**	**1**	**1**	**3**	**2**	**1**	**1**	**1**	**1.5**
										Mean Overall Score	**1.9**
										Correlation	**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator:
1. Dr. J. Sirajudeen,
2. Dr. M. Purushothaman

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3CC11	Core - XI	6	5	25	75	100

Course Title	INDUSTRIAL CHEMISTRY

SYLLABUS

Unit	Contents	Hours
I	**Fermentation, sugar, starch, pulp and paper** **1.1 Fermentation:** Introduction, Favorable conditions for fermentation- enzymes for fermentation and characteristics - Manufacture and uses of beer, spirit, wine, vinegar, *power alcohol, ethyl alcohol from molasses*, alcohol from waste sulphite liquor- Manufacture from starchy materials, cellulose materials and hydrocarbon gases. **1.2 Sugar and Starch:** Raw and refined sugar, by products of sugar -cane tops, bagasse, Preparation of celotex, Manufacture of sucrose from beet root, filter muds and molasses**,** starch and starch derivatives. **1.3 Pulp and Paper:** Introduction – pulp - types - sulphate of kraft pulp, soda pulp, sulphite pulp - rag pulp. manufacture of pulp - beating, refining, filling, sizing and colouring, calendaring – Manufacture of paper, quality improvement and uses of paper.	**18**
II	**Glass, Lime and Fertilizers** **2.1. Glass**–properties– types- manufacture and uses. Ceramics – classification– constituents - manufacture, properties and applications. **2.2. Lime** – classification- manufacture, properties, setting and hardening of limes. cement- manufacture of Portland cement– properties of cement – special cement- high alumina cement, water proof cement, slag cement, acid resisting cement, white cement, coloured cement and Pozzolana cement – uses. **2.3 Fertilizers** – Classification, Nitrogenous fertilizers, Phosphate fertilizers and Potash fertilizers. NPK Fertilizers, Mixed fertilizers, complex fertilizers- Nomenclature in fertilizer industry- pollution caused by fertilizers *effects of fertilizers*.	**18**
III	**Adhesive, Lubricants and Explosives** **3.1. Adhesives**- definition, classification - preparation and uses of animal glue adhesive. Protein adhesives, starch adhesives, synthetic resin adhesives rubber based adhesive, cellulose and silicate adhesives. **3.2. Lubricants** – Definition – functions - classification - synthetic lubricants – solid- semi solid and emulsion – Properties – viscosity – flash and fire point – cloud and pour point- aniline point- precipitation number, neutralisation number, saponification number and coke number – carbon residue test, copper strip test, ash test- *selection of lubricants*. 3.3. Explosives- Introduction, classification, characteristics – preparation, properties and uses of Nitro cellulose, DNB, TNB, TNT and Picric acid.	**18**

IV	**Pigments and Surface coating Materials** **4.1. Pigments** - Definition, White pigments- white lead, zinc oxide, lithopone and TiO_2 - composition, characteristics, manufacture and uses. Blue pigments–ultra marine- characteristics and uses. Red pigments - red lead. Green pigments - chrome green, Guignet's green. Black pigments and yellow pigments. **4.2. Paints** - Definition – classification of paints, requisites of a good paint, constituents and functions, manufacture of paints, methods of applying paints, setting of the paint, paint failure, paint removers – emulsion paints, constituents of emulsion paints, special paints – latex, heat and fire resistance, temperature indicating, luminous, water repellent paints - antifouling paints, antimicrobial paint, water proof paints and nano paints. **4.3. Varnishes** – Definition – constituents - characteristics of a good varnish – manufacture and uses. *Differences between paints, emulsions and varnishes*.	**18**
V	**Oils, Fats, Soap and Detergents** **5.1. Oils and fats** – Definition – differences between oils and fats. Types of oil, Extraction of oil from seeds, Vegetable oils - Manufacture of cotton seed oil and soybean oil - Refining of crude vegetable oils - coconut oil - palm oil - peanut oil - olive oil - *castor oil and sunflower oil*. **5.2. Analysis of Oils, fats** - Hydrogenation of oil. Saponification value, Acid value, Ester value, Iodine value, RM value, Henher value, Elaiden Test and Aniline point - definition and determination. **5.3. Soap and Detergents** –soap, composition. Manufacture of transparent and toilet soap (Hot and Cold process) – cleansing action of soaps. Detergents- Introduction, classification, biodegradability of surfactants, Detrimental effects of detergents-Manufacture of shampoos.	**18**
VI	**Current Trends (For CIA only)** Recent advances in nano fertilizers	

…….. Self Study

Text Books:
1.Frank hall Thorp, Outlines of Industrial chemistry,the maxmillan company, New York, London, 2nd Edition, 2016 2.B.N.Charabarthy, Industrial Chemistry, Oxford and IBH Publishing, NewDelhi, 1st Edition, 1999 3. B.K.Sharma, Industrial Chemistry, Goel Publication, Meerut, 1st Edition, 1983
Reference Books:
1. B. K. Sharma, Industrial Chemistry, Goel Publication, Meerut, 17th Edition, 2013 2. Krishnamoorthy, P. Vallinayaganand K. Jaya Subramanian, Applied Chemistry, Tata McGraw-Hill PublishingCo. Ltd., New Delhi, 2ndEdition,2001. 3. R. N. Shreve, and J. A. Brink, ChemicalProcess Industries, McGraw Hill, Toronto, 4th Edition,1977

Web Resource(s):
1. https://www.classcentral.com/course/swayam-chemical-process-safety-13942 2. https://www.scribd.com/document/417567194/H 3. https://onlinecourses.nptel.ac.in/noc23_ch39/preview 4. https://archive.nptel.ac.in/courses/123/105/123105003/ 5. https://www.youtube.com/watch?v=g2K6PXxtyB4 6. https://www.youtube.com/watch?v=HTIzwP8BKC8 7. https://onlinecourses.nptel.ac.in/noc23_ch46/preview 8. https://www.ehow.com/list_7235420_types-waterproof-paint.html 9. https://www.techtarget.com/whatis/definition/nanopaint 10. https://www.biocote.com/5-benefits-antimicrobial-paint/

Course Outcomes		
Upon successful completion of this course, the student will be able to		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Explain the processes involved in manufacturing of sugar, pulp and their byproducts.	**K1 &K2**
CO2	Execute the manufacturing and properties of glass and cement.	**K3**
CO3	Identify the properties and uses of adhesives, lubricants and explosives.	**K4**
CO4	Compare the ingredients of paints and varnishes	**K5**
CO5	Investigate the quality of oils, fats and soaps.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.4**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2.6**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.9**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.9**
										Mean Overall Score	**2.72**
										Correlation	**High**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. **Dr. A. ZAHIR HUSSAIN**
2. **Dr. S. K. PERIYASAMY**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3CC12P	Core - XII	6	4	20	80	100

Course Title	Physical Chemistry Non-Electrical - Practical

SYLLABUS

Contents	Hours
I. NON- ELECTRICAL PRACTICALS **70 marks** 1. Phase diagram of a binary system (Eutectic formation) 2. Phase diagram of a two-component system (forming compound with congruent melting point). 3. Phase diagram of a three component liquid system (with one partially Miscible pair) (CH_2Cl_2/$CHCl_3$/$C_6H_5CH_3$/H_2O-CH_3COOH). 4. Heat of solution of benzoic acid in water. 5. Comparison of strengths of three acids from kinetic study (Iodination of acetone) 6. Rast macro method of determining K_f and molecular weight. 7. Determination of E_a and A (for the hydrolysis of ethyl acetate at different temperatures) 8. Primary salt effect (on the kinetics of reaction between $S_2O_8^{2-}$ and I^-). 9. Verification of Freundlich adsorption isotherm (Adsorption of oxalic acid on Charcoal). 10. Estimation of KI by partition method. **II. Viva-Voce** **10 marks** **Scheme of Valuation** Procedure with formula - **10 marks** Up to 5% - **60 marks** 5.1 - 10% - **50 marks** 10.1 – 15 % - **40 marks** > 15 % - **30 marks**	**90**

Text Book(s):

1. P S Sindhu, Practical in Physical Chemistry, Macmillan, India, 1st Edition,2006
2. B Viswanathan P.S. Raghavan**,** Practical Physical Chemistry, Viva Books India,7th Edition ,2012

Reference Book(s):

1. Findlay. A, Practical Physical Chemistry, Longman, London, 7th Edition, 1959
2. Dr.M. Seeni Mubarak and Dr. A. Jafar Ahamed, Physical chemistry practical manual, PJ jazym, 1st Edition ,2022

Web Resource(s):

1. https://books.google.co.in/books/about/Practicals_in_Physical_Chemistry.
2. https://www.srcollege.edu.in/temp/lms/Manuals/PhysicalChemistry.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Construct and explain phase diagram for multi-component system	**K1 & K2**
CO2	Investigate the mechanism of kinetics of reaction	**K3**
CO3	Determine molecular weight using Rast's macro method	**K4**
CO4	Explain the concept of adsorption isotherm	**K5**
CO5	Evaluate the concept of energy of activation and Arrhenius law	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.9**
CO2	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**2.5**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2.9**
CO4	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**2.5**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.9**
Mean Overall Score											**2.74**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. **Dr. M. Seeni Mubarak**
2. **Dr. H. Mohamed Kasim Sheit**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3DE3A	Discipline Specific Elective – III	6	4	25	75	100

Course Title	Medicinal Chemistry

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Drugs** 1.1. Definition, nature, sources and classification of drugs –terminologies - pharmacology, pharmacy, pharmacodynamics, pharmacokinetics, molecular pharmacology, pharmacophore, metabolites, antimetabolites, pharmacopoeia, pharmacognosy, toxicology, Therapeutic index, LD50 andED50. physical and chemical properties of drugs. 1.2. Mechanism of different types drug action- depression–stimulation-replacement –anti-infective agent – metabolite antagonists. Assay of drugs – chemical, biological and *immunological assay* Storage of pharmaceutical substances – types of storage, encapsulation – hard and soft gelatine capsule.	**18**
II	**Metabolism of Drugs** 2.1. Metabolism of drugs – Definition, mechanism of drug action- actions of cellular and extra cellular sites–-absorption of drugs – Factors affecting absorption -Routes of drug administration – adverse effect of drugs. 2.2. Phase I reactions - hydroxylation, oxidative de-alkylation, oxidative, deamination and- N- oxidation. Phase II reactions– glucuronide conjugation, amino acid, sulphate, *Methylated and N- acetylated conjugates*.	**18**
III	**Drug Design and Development** 3.1. Development of new drugs – factors affecting development of new drugs concept of Quantitative structure-activity relationships (QSAR) and parameters - Hansch and Wilson method. 3.2. Structure Activity Relationship- Effect of alkyl groups-unsaturation - chain length – isomerism – halogens – amino group – acidic group – hydroxyl group – Nitro and nitrite group- aldehydes and ketones. *SAR of penicillin and streptomycin*.	**18**
IV	**Diagnostic methods and Pharmaceutical methods** 4.1. Diagnostic methods Determination of serum glucose - Folin & Wu's and o-toluidine methods, Determination of serum cholesterol - Sackett's method, *Estimation of haemoglobin*. Radiopharmaceuticals for scintigraphy, types of radiopaque - radiopaque substances - radiographic procedure, Iopanoic acid – structure, functions and mode of action. 4.2.Pharmaceutical methods – Definition – preservatives – Antioxidant – Sequestrants – colouring agents – Flavouring agents – Sweetening agents – *stabilizing agents – and Emulsifying agents*.	**18**
V	**Analgesics,Diabetes and Cancer** 5.1. Analgesics – types – Narcotic – Morphine – structure, Analgesic action of morphine – uses. Non-narcotic analgesics – salicylic acid derivatives – methyl salicylate – salicin – preparation and uses. Para-aminophenol derivatives – para acetamol – phenacetin – Analgin – preparation and uses. 5.2. Diabetes – types – causes – control methods, Insulin, chemical structure of insulin, preparation and dosage. Oral hypoglycaemic agents, Sulphonylureas, Biguanides. Cancer – types of cancer – causes of cancer – treatment of cancer – *Alkylating agents – antimetabolites – fluorouracil*.	**18**

…..... Self Study

Text Book(s):

1.JayashreeGhose, Text book of Pharmaceuticalchemistry, S. Chand, NewDelhi, 3rd Revised Edition, 2008.
2.Wilson and Giswalds, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins, 1st Edition, 2010.
3.S C Matha Ashutosh Kar, Pharmaceutical Pharmacology, New Age International PVT limited, New Delhi, 1st Edition, 2009.
4. V.K. Ahluwalia, Medicinal Chemistry, Madhu Chopra, New Delhi, 2nd Edition, 2012.
5. Alkal. Gupta, Medicinal Chemistry, Pragati Prakashan, New Delhi, 10th Edition, 2020.

Reference Book(s):

1. Mathew George and Lincyjoseph, Text book of Pharmaceutical Chemistry, Abe books, New Delhi 1st Edition, 2009.
2. S. Lakshmi, Pharmaceutical Chemistry, Sulthan Chand and Sons, New Delhi, 3rd Edition, 2009.
3.Graham L. Patric, An introduction to Medicinal Chemistry, Oxford University Press,USA, 3rd Edition, 2005.
4. Richard B.Silverman, The Organic Chemistry ofDrug Design and DrugAction, Academic Press, US, 2004.
5. Gareth Thomas, Medicinal Chemistry, John Wiley & Sons:Chichester, New Delhi, 3rd Edition, 2011.

Web Resource(s):

1. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908
2.https://nptel.ac.in/courses/104/106/104106106/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	List the important terminologies and assay of drugs.	**K1 & K2**
CO2	Explain the metabolism of drugs and Drug Administration.	**K3**
CO3	Examine the activity of drugs by QSAR methods.	**K4**
CO4	Estimate Diagnostic aids and Pharmaceutical aids	**K5**
CO5	Discuss the Analgesics, Diabetes and Cancer.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	3	3	3	3	3	2	2.8
CO2	3	3	3	3	2	3	3	3	3	2	2.9
CO3	3	3	3	3	3	3	3	2	3	3	2.9
CO4	2	3	3	3	3	2	3	3	3	3	2.8
CO5	3	3	3	3	3	3	3	3	3	3	3.0
Mean Overall Score											2.88
Correlation											High

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. Dr. A. ZAHIR HUSSAIN
2. Mr. M. VARUSAI MOHAMED

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PCH3DE3B	Discipline Specific Elective – III	6	4	25	75	100

Course Title	CHEMISTRY OF MATERIALS

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Synthesis of Inorganic Materials** 1.1. Synthesis of materials – formation of bulk material – methods – direct synthesis – solution method - chemical deposition - Defects and ion transport - extended defects – atom and ion diffusion. 1.2. Solid Electrolytes – cationic electrolytes- anionic electrolytes-*__Mixed ionic electronic conductors__*- properties, structure and uses. 1.3. Magnetic materials - Atomic magnetism and solids, type of magnetic materials,exchange interactions, hysteresis loop and classification, calculation of magnetic moment from saturation magnetisation, magnetic domains, examples of magnetic materials - soft & hard ferrites - structure & magnetic interactions in spinel, garnet hexagonal ferrites, Applications of magnetic materials.	**18**
II	**Superconductors and Inorganic Pigments** 2.1. Superconductors – high temperature super conductors – Meissner effect – types – super conducting oxides - properties – colossal magneto resistance – structure – properties – rechargeable battery materials – $LiCoO_2$, $LiMnO_4$ – properties and uses. 2.2. Superconducting materials - Definition, superconductivity, critical temperature, critical field, ***BCS theory***, properties & classification of superconductors, high Tc superconductors, examples with structure and applications, fullerenes, intermetallic superconductors, synthesis and applications. 2.3. Inorganic pigments: Coloured solids – inorganic phosphorous – properties-uses – white and black pigments – properties and uses.	**18**
III	**Molecular Material Chemistry** 3.1. Molecular material Chemistry – one dimensional metals – properties and uses – molecular inorganic magnetic materials – properties and uses. 3.2. Inorganic liquid crystals – types – calamitic –discotic – properties and uses. ***Fullerides - solid carbon C60 – properties and uses***. 3.3. Biomaterials - Definition, Dense Hydroxyapetite ceramics, bioactive glasses, bioactive glass ceramics and bioactive Composites.	**18**
IV	**Properties of crystals:** 4.1. Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo, electro and injection luminescence. 4.2. LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarisation - electronic, ionic, orientation, and space charge polarisation. Effect of temperature. dielectric constant, dielectric loss. 4.3. Types of dielectric breakdown–intrinsic, thermal, discharge, electrochemical and defect breakdown.	**18**
V	**Diffraction Studies of Crystals** 5.1. X-ray diffraction by single crystal method: Space groups- systematic absences in X-ray data and identification of lattice types, glide planes and screw axes- X-ray intensities- structure factor and its relation to intensity and electron density- phase problem-structure solution by heavy atom method and direct method- determination of absoluteconfiguration of molecules-a brief account of Cambridge structural database (CSD) and protein data bank(PDB). 5.2. Electron diffraction by gases- scattering intensity vs. Scattering angle, ***Wierl equation- Measurement techniques***. 5.3. Neutron diffraction by crystals – magnetic scattering- measurements techniques- elucidation of structure of magnetically ordered unit cell.	**18**

VI	**Current Trends (For CIA only) –** Contemporary developments related to the course during the semester concerned.

…..... Self Study

Text Book(s):

1. Shriver and Atkins, Inorganic Chemistry, Oxford Universitypress, New Delhi,India,5th Edition, 2011.
2. A.W. Adamson, Concept of InorganicPhotochemistry, John Wiley and sons,New York, 1th Edition, 1975.
3. A. AbdulJameel, Application of PhysicalMethods to InorganicCompounds, Jan Publications, Tiruchirappalli, 1th Edition, 2007.

Reference Book(s):

1. Stuart Warren, Organic synthesis methodsand starting materials, thedisconnections approach, John, Wiley & sons, NewYork, 1st Edition, 1972.
2. Futhrhop, Penzlin, Photochemistry, John Wiley and sons,New York, 1st Edition, 1992.
3. Shriver and Atkins, Inorganic chemistry, Oxford university press,India, 5th Edition, 2011.

Web Resource(s):

1. https://swayam.gov.in/nd1_noc19_ph08/preview
2. https://swayam.gov.in/nd1_noc20_ph06/preview
3. https://nptel.ac.in/courses/116/102/116102052/
4. https://nptel.ac.in/courses/113/106/113106069/
5. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the electric and magnetic properties of inorganic solids.	**K1 & K2**
CO2	Develop the superconductor materials.	**K3**
CO3	Apply the inorganic materials in biomedical field.	**K4**
CO4	Appreciate the uses of metal complexes in photochemistry.	**K5**
CO5	Explain the structure of crystal using diffraction studies.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	3	3	3	2	3	3	2.8
CO2	2	3	3	3	3	3	3	3	3	3	2.9
CO3	2	3	3	3	3	2	3	3	3	2	2.7
CO4	3	3	3	3	3	3	3	3	3	2	2.9
CO5	3	3	3	3	3	2	3	3	3	3	2.9
									Mean Overall Score		2.84
									Correlation		High

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. **Dr. A. ZAHIR HUSSAIN**
2. **Mr. M. VARUSAI MOHAMED**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCH4CC13	Core - XIII	6	6	25	75	100

Course Title	CLASSICAL, STATISTICAL THERMODYNAMICS AND SURFACE PHENOMENA

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Classical Thermodynamics** 1.1. Thermodynamics of systems of variable composition (Open Systems) - partial molar property – partial molar quantities of E, V, H, A, G and S, chemical potential, physical significance of chemical potential, variation of chemical potential with respect to T and P, chemical potential in terms of U and H, partial molar quantities from experimental data – direct method, apparent molar properties, intercepts method and general methods. 1.2. Calculation of thermodynamic properties of real gases - fugacity concept, variation of fugacity with T and P– Lewis-Randall rule–calculation of fugacity of real gases, determination of fugacity – graphical method, equation of state method, determination of fugacity in gas mixtures 1.3. Activity of non-electrolytes – definition, activity coefficient, standard states of solvent and solute for liquids and solids, dependence of activity on T and P, experimental determination of activity (solvent and solute) – vapour pressure method, ***cryoscopic method and EMF method*.** (Problems from 1.1- Enthalpy, entropy, free energy calculations and 1.3-activity coefficient)	**18**
II	**Statistical Mechanics** 2.1. Basic Concepts and Classical Statistics – introduction of statistical mechanics, mathematical probability, thermodynamic probability, relation between mathematical probability and thermodynamic probability of a system, Boltzmann-Planck's equation, Phase space, Ensembles – types of ensembles, definition of micro and macro states, differentmethods of counting macro states, postulates, Ergodic hypothesis, distinguishable and indistinguishable particles, Stirling's approximation. 2.2. Classical statistics – derivation of Maxwell–Boltzmann statistics and distribution law, Partition functions – Definition, derivation of translational, rotational, vibrational and electronic partition functions, principle of equi-partition of energy. 2.3. Molar partition function and molecular partition function, partition functions and thermodynamic quantities - Internal energy (E), heat capacity (Cv), work function (A), pressure (P), entropy of mono atomic gases (Sackur–Tetrode equation)***heat content (H), Gibb's free energy(G) and entropy(S) *.** (Problems from 2.3)	**18**
III	**Quantum Statistics** 3.1. Quantum statistics – Bose–Einstein and Fermi–Dirac statistics and distribution function, comparison of them with Maxwell-Boltzmann statistics 3.2. Application of B.E statistics - photon gas and super fluidity of liquid helium, concept of negative Kelvin temperature, application of F.D statistics - electron gas and thermionicemission. 3.3. Heat capacities of solids – Dulong and Petit's law, classical theory and its limitations, Einstein's theory and its limitations, Debye's theory and its limitations.	**18**

IV	**4.1. Irreversible Thermodynamics** Non-equilibrium thermodynamics – Definition, types of irreversibility of a process, postulates, entropy production - entropy production and rate in a chemical reaction, Onsagar relations - linear law, reciprocal relation and applications, stationary–state. **4.2. Phase rule-Three component system** Maximum number of phases, maximum number of F, Roozeboom triangle-Types-formation of one pair partially miscible liquids (acetic acid-chloroform-water),formation of two pairs of partially liquids (water-phenol-aniline) and formation of three pairs of partially miscible liquids (succinic nitrile- water- ether). **4.3. Solid liquid systems** Ammonium chloride - Ammonium nitrate - Water system *** H_2O - Na_2SO_4 – NaCl system and $MgCl_2$, $CaCl_2.H_2O$ system*.**	**18**
V	**Surface Phenomena** **5.1**. ***Adsorption, absorption, Chemisorption, Physisorption-Definition and Differentiation*** Monolayer adsorption-Langmuir and Freundlich- Multilayer adsorption-B.E.T-postulates-derivation-isotherms - Surface area determination - Heat of adsorption and its determination Adsorption from solution, Gibbs adsorption isotherm - solid - liquid interfaces - wetting and contact angle - solid gas interfaces - soluble and insoluble film. **5.2**. Surface tension - methods of measuring surface tension - electrical phenomenon at Interfaces, including electro kinetic, micelles and reverse micelles, Solubilisation, Micro - emulsions. (Problems from 5.1-Surface area determination & 5.2-Surface tension) **5.3**. Role of surface in catalysis - ***semiconductor catalysis, n and p type surfaces*** - kinetics of surface reactions involving adsorbed species - Langmuir - Hinshelwood mechanism**.**	**18**
VI	**Current Trends (For CIA only)** Recent developments in Surface Films	

* …….* Self study

Text Books:

1. K. Kuriacose and J.C. Rajaram, Thermodynamics for students of Chemistry, 3rd Edition, Shoban Lal NaginChand & Co, Delhi., New Delhi, 2002.
2. Gurdeep Raj, Thermodynamics,Statistical Thermodynamics and Irreversible thermodynamics, 3rd Edition, Goel PublishingHouse, Meerut., 2004.
3. M. C. Gupta, Statistical Thermodynamics, 2nd Edition, New Age International Limited, New Delhi, 2003.
4. Laider, Chemical kinetics, 3rd Edition, Tata-McGraw Hill Co., New Delhi, 1984.
5. R. Kh. Dadashev, Thermodynamics of Surface Phenomena, 1st Edition, Viva Books Pvt. Ltd, New Delhi, 2017.

Reference Books:

1. F. W. Sears Statistical Mechanics 2nd Edition Addison Wesley, 1972.
2. H. W. Zemansky Heat and Thermodynamics 8th Edition Tata-McGraw Hill, New Delhi, 1975.
3. P. W. Atkins Physical Chemistry 6th Edition Oxford University Press, New Delhi, 1998.
4. Samuel Glasstone Textbook of PhysicalChemistry 2nd Edition Macmillan India,New Delhi, 1981.
5. K. L. Kapoor,A Text Book of Physical Chemistry 1st Edition Macmillan India Press, Chennai, 2009.

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Paraphrase the fundamentals of thermodynamics	**K1 & K2**
CO2	Articulate the thermodynamic properties	**K3**
CO3	Illustrate phase diagram for multi-component system	**K4**
CO4	Appraise macroscopic properties of a system	**K5**
CO5	Describe surface phenomena	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO2	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.4**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2.6**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.9**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.9**
Mean Overall Score											**2.72**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator:
1. Dr. A. Jafar Ahamed
2. Dr. F.M. Mashood Ahamed

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCH4CC14	Core - XIV	6	6	25	75	100

Course Title	Chemistry of Macromolecules

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Introduction of Macromolecular Chemistry** 1.1 *Historical development of polymer chemistry, monomer, polymer, oligomer, degree of polymerization*, characteristics of polymer, raw materials for polymers, concept of functionality. Classification of polymers – based on sources, molecular forces, reactions and structure. Nomenclature of polymers. Chain-growth and step-growth polymerizations. Stereo regular polymers. Chain transfer reaction. 1.2 Kinetics and mechanism: Free radical, Ionic (Cationic and anionic), Coordination and Co-polymerization. 1.3 Polymerization Techniques – Bulk, Solution, Suspension and Emulsion polymerizations – Mechanism, characteristics, advantages and disadvantages	**18**
II	**Molecular Weight Determination and Characterization of Polymers** 2.1 *Concepts of Molecular weight - number, weight* and viscosity averages – Polydispersity index and molecular weight distribution - Practical significance of molecular weight. 2.2 Determination of molecular weight of polymers: End group analysis, Membrane Osmometry, Vapour Phase Osmometry, Viscometry, Light Scattering measurements and Gel Permeation Chromatography. 2.2 Characterization of polymers by Infra-Red, UV-Visible, Nuclear Magnetic Resonance spectroscopy, X-ray diffraction, Scanning Electron Microscopy and Transmission Electron Microscopy.	**18**
III	**Properties of Polymers** 3.1 Physical properties - Hardness, tensile strength, fatigue, impact, tear resistance and abrasion resistance. Polymer structure and property relationship - effect of chain flexibility and other steric factors. 3.2 Glass transition temperature (T_g), melting point (T_m), Determination of T_g – Dilatometric, thermomechanical and calorimetric methods, factors influencing T_g and T_m, relationship between T_g and T_m. Crystallinity in polymers - Polymer crystallisation, structural and other factors affecting crystallisability. 3.3 Thermo Gravimetric Analysis - Theory, Applications - purity, fiber content, composition of compounded rubber, thermal stability, thermal degradation, kinetics of thermal degradation - Thermal degradation behaviour of Urea-Formaldehyde resin and Bakelite. Differential Thermal Analysis and Differential Scanning Calorimetry – Basic concepts.	**18**
IV	**Processing of Polymers** 4.1 **Natural Rubber:** Origin, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber. *Elastomers, plastics and fibres - thermosetting and thermoplastics* 4.2 Thermoplastic elastomers – Types, properties, compounding and applications 4.3 Processing techniques: Casting - die casting, rotational casting, film casting, Thermoforming, foaming, fibre spinning. Moulding Processes - compression moulding, injection moulding, blow moulding, extrusion moulding, reinforcing and calendering.	**18**

V	**Commercial polymers, Polymer Nanocomposites and their applications** 5.1 Preparation, properties and applications of *polymethylmethacrylate (PMMA)*, Polyamide (Nylon-6,10), fluoropolymers, polyesters, epoxy resins, furan resins, polyurethanes, Phenol-Formaldehyde resin, Urea-Formaldehyde resin, Melamine-Formaldehyde resin. 5.2 Polymer nanocomposites – Preparation (melt blending, solution blending, latex coagulation, in-situ polymerization), characterization, properties and applications. Liquid Crystalline Polymers – Types, properties and applications. 5.3 Biomedical polymers – Important features, advantages and disadvantages of bioactive polymers – Properties and applications of polymers in Dentistry, Tissue adhesives, Dialysis Membrane, Blood oxygenators, Bone cement, Prostheses, Biodegradable sutures, Control drug delivery systems.	**18**
VI	**Current Trends (For CIA only)** Recent advances and applications of polymers in healthcare sector.	

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Text Books:

1. R. Gowariker, N.V. Viswanathan and J. Sreedhar, Polymer Science, 3rd Edition, New Age International Publishers, New Delhi, 2019.
2. M.S. Bhatnagar, A Textbook of Polymer Chemistry, 5th Edition, S.Chand & Company Ltd. New Delhi, 2014.
3. M.S. Bhatnagar, A Textbook of Polymers, Vol.-I Chemistry and Technology of Polymers (Basic Concepts), 28th Edition, S.Chand & Company Ltd., New Delhi
4. G.S. Mishra, Introductory Polymer Chemistry, New Age International (P) Ltd., Publishers, New Delhi, Reprint-2005,
5. Anshu Srivastava, Shakun Srivastava, Fundamentals of Polymer Science & Technology, 1st Station, S.K. Kataria & Sons Publishers, New Delhi, 2012.
6. Alka L. Gupta, Polymer Chemistry, Reprint, A Pragati Edition, Meerut, 2016.

Reference Books:

1. F.W. Billmeyer, Textbook of Polymer Science, 3rd Edition, John Wiley and Sons, New York, 2003
2. H.F. Haufman, J.J. Falcetta, Introduction of Polymer Science and Technology, An SPE Text Book (Edn.), John Wiley and Sons,New York, 1977.
3. P. Bahadur, N.V. Sastry, Principles of Polymer Science, 2nd Edition, Narosa Publishing House (P) Ltd., New Delhi, 2015.
4. Charles E. Carraher Jr., Introduction to Polymer Chemistry, 3rd Edition, CRC Press, Taylor & Francis group, UK, 2012.
5. J. R. Fried, Polymer Science and Technology, 3rd Edition, Pearson Prentice Hall, US, 2014.
6. Robert J. Young, Peter A. Lovell, Introduction to Polymers, 3rd Edition, CRC Press, Taylor & Francis group, UK, 2011.
7. Robert William Dyson, Specialty Polymers, 2nd Edition, Springer Verlag, 2011

Web Resource(s):

1. https://nptel.ac.in/courses/113/105/113105077
2. https://archive.nptel.ac.in/courses/104/105/104105124/
3. https://archive.nptel.ac.in/courses/104/105/104105039/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Recall the rudiments of the polymers and describe the mechanism and kinetics of the polymerization reactions.	**K1 & K2**
CO2	Determine the molecular weight of the polymers.	**K3**
CO3	Appraise the physical and thermal properties of polymers	**K4**
CO4	Predict the structure of the polymers using FT-IR, UV-Visible and NMR spectral studies and investigate the surface morphology and crystalline lattice of polymers.	**K5**
CO5	Develop the commercial and speciality polymers	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.4**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2.8**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2.6**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.9**
CO5	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.9**
Mean Overall Score											**2.72**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator:
1. Dr. K. Riaz Ahamed
2. Dr. N. Mujafarkani

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCH4CC15P	Core - XV	6	4	20	80	100

Course Title	Physical Chemistry Electrical - Practical

SYLLABUS

Contents	Hours
I. ELECTRICAL PRACTICALS **70 marks** **CONDUCTOMETRY:** 1. Estimation of mixture of acids. 2. i. Determination pKa – Ostwald's dilution law. ii. Determination of solubility product - Kohlrausch's law. 3. Estimation of mixture of halides. 4. Determination of hydrolysis constant (for aniline hydrochloride) 5. i. Saponification of ethyl acetate (Kinetics study). ii. Determination of critical micellar concentration. **POTENTIOMETRY:** 1. Estimation of mixture of acids. 2. Determination of solubility product by a) Galvanic cell method. b) Concentration cell method. 3. Estimation of mixture of halides. 4. Determination of E^0 of Zn / Zn^{2+} and Estimation of Zn^{2+} 5. Determination of hydrolysis constant (for aniline hydrochloride) **II. Viva-Voce** **10marks** **Scheme of valuation** Procedure with formula : **10 marks** <1% **- 60 marks** 1-2% **- 50 marks** 2.1-3% **- 40 marks** 3.1-4% **- 30 marks** >4% **- 20 marks**	**90**

Text Book(s):

1. P S Sindhu, Practical in Physical Chemistry, Macmillan, India, 1st Edition,2006
2. B Viswanathan P.S. Raghavan**, Practical Physical Chemistry, Viva Books India**,7th Edition ,2012

Reference Book(s):

1. Findlay. A, Practical Physical Chemistry, Longman, London, 7th Edition, 1959
2.Dr.M.Seeni Mubarak and Dr. A. Jafar Ahamed, Physical chemistry practical manual, PJ jazym 1st Edition ,2022.

Web Resource(s):
1. https://books.google.co.in/books/about/Practicals_in_Physical_Chemistry. 2. https://www.srcollege.edu.in/temp/lms/Manuals/PhysicalChemistry.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Estimate the strength of mixture of acids and bases using principles of conductometry and potentiometry.	**K1 & K2**
CO2	Identify the solubility product to apply the Ostwald's dilution law	**K3**
CO3	Apply the Kohlrausch's law to identify the nature of acid	**K4**
CO4	Determine the of strengths of acid mixtures and halide mixtures	**K5**
CO5	Predict the CMC and determine the hydrolysis constant using conductometry and potentiometry.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.9**
CO2	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**2.5**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2.8**
CO4	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**2.5**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2.9**
Mean Overall Score											**2.72**
Correlation											**High**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinators:

1. **Dr. M. Seeni Mubarak**
2. **Dr. H. Mohamed Kasim Sheit**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCH4DE4A	Discipline Specific Elective – IV	6	4	25	75	100

Course Title	Green and Nano Chemistry

SYLLABUS

Unit	Contents	Hours
I	**Principles of Green Chemistry:** 1.1 Definition- Need for green chemistry- Twelve principles of green chemistry – Goals of Green Chemistry, Progress of green Chemistry 1.2 Concept of Atom economy – addition, substitution, elimination and rearrangement reactions - Atom economy calculation of ethylene oxide and Ibuprofen - concept of selectivity – Chemoselectivity – Regioselectivity – Enantio selectivity- Diastereoselectivity *efficiency of reaction –percentage yield – Theoretical yield*.	18
II	**Green Reactions:** 2.1 Green solvents –definition, super critical carbon dioxide, role of Ionic liquids, *Use of water as solvent*, applications of zeolites in green chemistry. Organic synthesis – microwaves and sonication methods –benefits and limitations. 2.2 Designing a green synthesis – choice of starting material, reagents, catalysts and solvents. PTC catalyzed reactions (Williamson ether synthesis and Wittig reaction).	18
III	**Green Synthesis:** 3.1 Adipic acid, catechol, methyl methacrylate, acetaldehyde, Ibuprofen and Paracetamol. Microwave assisted reaction in water – Hofmann eliminations, Hydrolysis and Oxidation. Microwave assisted reaction in organic solvents- Esterification, Fries rearrangement, Decarboxylation and Diels – Alder reaction. 3.2 Ultrasound assisted reaction: Definition, Cannizaro reaction, Strecker synthesis and Reformatsky reaction.	18
IV	**Nano Chemistry:** 4.1 Introduction – Historical milestones- classification, properties – *Optical, electrical, mechanical and magnetic properties*. Applications - nanomaterials in medicine, information storage, sensors, new electronic devices, environmental remediation and clean catalysts. 4.2 Synthesis - Bottom up, Top down approach – Hydrothermal, Sol- gel and Solvothermal methods, Arc method, laser ablation method, Chemical vapour deposition method, Electro-deposition method, Ball milling method.	18
V	**Carbon Nanotubes:** 5.1 CNT –definition- Classification – Single wall and Multiwall CNTs (SWCNT and MWCNT). Preparation - Properties- applications. *Fullerenes* – properties – uses. Nanocomposites – Classification, Properties and uses. 5.2 Characterisation of nanomaterials by SEM, TEM and AFM - *principle, instrumentation and applications*,	18

……. Self Study

Text Book(s):

1. V.K. Ahluwalia, Green Chemistry, Narosa Publishing House Pvt Ltd., Delhi, 3rd Reprint, 2018.
2. V. Kumar, An Introduction to Green Chemistry, Vishal Publishing Co., Delhi, 2nd Edition, 2020.
3. Sulabha K. Kulkarni, Nanotechnology, Principles and Practices, Capital Pvt. Co., Delhi, 1st Edition, 2002.

Reference Book(s):
1. R.Sanghi and M.M Srivastva, Green Chemistry, Narosa Publications, India, 5th Reprint, 2012. 2. Kenneth, J. Klaburde and Ryan M. Richards, Nanoscale materials in chemistry, John Wiley and Sons, 2nd Edition, 2002. 3. J.N. Gurtu and Amit Gurtu, Introductory Green Chemistry, Pragati Prakashan, 2nd Edition, 2014. 4. Richard Booker and Earl Boysen, Nano technology, Wiley India Pvt Ltd., 1st Edition, Reprint, 2010.
Web Resource(s):
1. https://iopscience.iop.org/book/978-0-7503-1221-9/chapter/bk978-0-7503-1221 2. https://en.wikipedia.org/wiki/Green_nanotechnology

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Apply the role of green chemistry and its importance in environment	**K1 & K2**
CO2	Get familiar with carrying out chemical reactions in green approach	**K3**
CO3	Take part in the conventional method of preparation of chemical products applying green principles	**K4**
CO4	Understand the concepts of nanomaterials, their synthesis and characterization	**K5**
CO5	Adapt knowledge on CNT and their applications	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	3	1	3	2	3	3	2.5
CO2	3	1	2	2	2	3	2	3	2	2	2.3
CO3	2	3	3	3	3	2	2	2	2	3	2.5
CO4	3	2	2	2	2	3	2	2	3	3	2.4
CO5	3	2	2	2	2	3	2	2	2	2	2.2
										Mean Overall Score	**2.38**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator:
1. Dr. A. Zahir Hussain
2. Dr. A. Asrar Ahamed

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PCH4DE4B	Discipline Specific Elective - IV	6	4	25	75	100
Course Title	ENVIRONMENTAL CHEMISTRY AND QUALITY CONTROL						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Water Pollution and its Control** 1.1 Sources of water pollution – domestic – industrial – agricultural – soil and radioactive wastes as sources of pollution. Water pollutants and their effects. Objectives of analysis – parameters for analysis-colour – turbidity – total solids – conductivity – acidity – alkalinity – hardness – chloride – sulphate – fluoride – silica – phosphates, different forms of nitrogen, DO, BOD, COD. 1.2 Heavy metal pollution-public health significance of cadmium – chromium – copper – lead – zinc– manganese – mercury and arsenic. Prevention and control measures.	**18**
II	**Air and Soil Pollution** 2.1 Introduction – Classification of Air Pollutants – Primary and Secondary Pollutants – Sources of air pollution. Global impacts of air pollutions – Global warming, Green house effects, Photochemical smog, Acid rain, Ozone layer depletion 2.2 Soil Pollution - Sources of soil pollution – Industrial pollution, Urban and Domestic wastes, Radioactive pollutants, Plastic and Polymers. Effect of Insecticides, Fungicides, Herbicides, Plastics and Polymers on environment. Soil Analysis – Determination of Soil pH, Total Nitrogen and Phosphorus.	**18**
III	**Radioactive and Thermal Pollution** 3.1 Radioactivity and kinds of radiation – *Sources of radioactive pollution* – Radio waste generated by nuclear power plants – Harmful effects of radiation – Dangers from nuclear power plants – Disposal methods of radioactive wastes. 3.2 Source of thermal pollution – Thermal power plant pollution – Hazardous effect –* Prevention and control of thermal pollution*.	**18**
IV	**Wealth from Waste (Recycling):** 4.1 Introduction – Recycling Techniques – Construction materials from waste – Medicines from agricultural waste – Liquid fuels from agricultural waste – Urban waste and bagasse for electricity – Agriculture waste for biomass into cheap and efficient fuel. 4.2 Bacteria for paper making – Waste into objects of daily use – Garbage into fuel – How to use garbage to generate power.	**18**
V	**Quality Control Measurements** 5.1 Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate – Food adulteration – common adulterants in food, contamination of food stuffs – Microscopic examination of foods for adulterants – Pesticides analysis in food products – analysis of toxic metals in food (Mercury, cadmium, cobalt, tin and chromium). 5.2 Determination of iodine, Saponifiction and acid value of an oil – *Food standards – ISI and Agmark*.	**18**

……. Self Study

Text Book(s):

1. A. K. De, Environmental Chemistry, New Age International Publishers, 7th Edition, 2016
2. B.K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publishing House, Meerut, India, 13th Edition, 2001.
3. B.K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, India, 13th Edition, 2015.
4. Asim K. Das, Enviroinmentsl Chemistry with Green Chemistry, Books and Allied (P) Ltd., India, 1st Edition, 2010.
5. V.K.Ahluwalia, Environmental Chemistry, Ane's Books India, 2nd Edition, 2015.

Reference Book(s):

1. H. Kaur, Environmental Chemistry, Pragati Prakashan, Meerut, India, 9th Edition, 2015.
2. A. V. Salker, Environmental Chemistry Pollution and Remedial Perspective, Narosa Publishing House Pvt., Ltd., New Delhi, 2017.
3. S.A. Abbasi and Naseema Abbasi, Renewable energy sources and their environmental Impact, Prentice-Hall, New Delhi, 2nd Edition, 2002.
4. B.K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publishing House, Meerut, India, 8th Edition, 2001.

Web Resource(s):

1. https://archive.nptel.ac.in/content/storage2/courses/122106030/Pdfs/1_1.pdf
2. https://nptel.ac.in/courses/104103020
3. https://www.vssut.ac.in/lecture_notes/lecture1530778260.pdf
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse water quality parameters.	**K1& K2**
CO2	Gain knowledge on air and soil pollution.	**K3**
CO3	Describe the harmful effects of radioactive pollution.	**K4**
CO4	Produce value added products from waste materials.	**K5**
CO5	Familiar with different types of quality control measurements.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	3	1	3	2	3	3	2.5
CO2	3	1	2	2	1	3	2	3	2	2	2.1
CO3	2	3	2	1	3	2	2	1	2	3	2.1
CO4	3	2	1	2	2	3	1	2	2	2	2.0
CO5	3	1	1	1	1	3	2	1	1	1	1.5
										Mean Overall Score	**2.04**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator:

1. Dr. A. Zahir Hussain

2. Dr. A. Asrar Ahamed