C. Abdul Hakeem College (Autonomous), Melvisharam.

Syllabus for M.Sc., Chemistry effective from the year 2024-2025

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*CC*	***P24MCH101***	***ORGANIC REACTION MECHANISM - I***	***90***	***5***	***25***	***75***	***100***

Objectives:

- To understand the feasibility and the mechanism of various organic reactions.
- To comprehend the techniques in the determination of reaction mechanisms.
- To understand the concept of stereochemistry involved in organic compounds.
- To correlate and appreciate the various types of organic reaction mechanisms.
- To understand the concept of aromaticity in benzenoid, non-benzenoid, heterocyclic, and annulene compounds.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	**CO Statement** (On the successful completion of the course, the students will be able to)	**Cognitive Level**
CO1	Assess the concept of aromaticity and to predict the mechanism of electrophilic substitution reactions.	**K4**
CO2	Explain the mechanism of aliphatic and aromatic nucleophilic substitution reactions.	**K2**
CO3	Apply the principles of kinetic and non-kinetic methods to determine the mechanism of reactions.	**K3**
CO4	Explain the concepts related to nomenclature, isomerism, and stereochemistry.	**K2**
CO5	Propose the conformations of organic molecules and to arrive the configuration using ORD and CD.	**K6**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit – I Aromatic and Aliphatic Electrophilic Substitution: (18 Hours)

Aromaticity: Huckel's and Craig's rules. Aromaticity in benzenoid, non-benzenoid, heterocyclic compounds, and annulenes.

Aromatic electrophilic substitution: The Arenium ion mechanism. Orientation and reactivity of di- and polysubstituted phenol, nitrobenzene, and halobenzene. Reactions involving nitrogen electrophiles: nitration, nitrosation, and diazonium coupling; Sulphur electrophiles: sulphonation; Halogen electrophiles: chlorination, and bromination; Carbon electrophiles: Friedel-Crafts alkylation, acylation, and arylation reactions.

Aliphatic electrophilic substitution Mechanisms: S_E1, S_E2, and S_Ei Mechanism - reactivity, structural and solvent effects, Stark-Enamine reaction.

Unit – II Aromatic and Aliphatic Nucleophilic Substitution: (18 Hours)

Aromatic nucleophilic substitution Mechanisms: S_NAr, S_N1 (Aromatic) and Benzyne mechanisms - Evidences - Reactivity, Effect of substrate, leaving group and attacking nucleophile. Reactions: Oxygen and Sulphur-nucleophiles, Bucherer and Rosenmund-Von Brain reactions, von Richter, Sommelet-Hauser, and Smiles rearrangements. ion pair mechanism and evidences.

Aliphatic nucleophilic substitutions at an allylic carbon, aliphatic trigonal carbon, and vinyl carbon. S_N1, S_N2, and S_Ni mechanism - Neighbouring group participation - reactivity, structural and solvent effects. Hydrolysis of esters. Swain- Scott, Grunwald - Winstein relationship - Ambident nucleophiles.

Unit–III Methods of Determination of Reaction Mechanism: (18 Hours)

Non-kinetic methods: Energy profile diagrams, intermediate versus transition state, product analysis, determination of intermediates - isolation, detection, and trapping. Cross-over experiments, isotopic labelling, isotope effects, and stereo-chemical evidences.

Kinetic methods: kinetic isotopic effects, salt effects, solvent effects solvent isotopic effects, kinetic and thermodynamic controlled products. Hammond postulates. Curtin-Hammett principle. Hammett equation - significance of σ and ρ - applications of Hammett equation -Taft equation and its applications.

Unit – IV Stereochemistry-I: (18 Hours)

Introduction to molecular symmetry and chirality – axis, plane, centre, alternating axis of symmetry. Optical isomerism due to asymmetric and dissymmetric molecules with C, N, S based chiral centres. Dissymmetry of allenes, spiranes, biphenyls, cyclooctene, helicene, binaphthyls, ansa and cyclophanic compounds, and exo-cyclic alkylidene-cycloalkanes. Absolute configuration - R, S notation of simple molecules including allenes, biphenyls, and spiranes. Topocity and prostereoisomerism. proR, proS, side phase, and re phase. Molecules with more than one asymmetric centre (restricted to five carbons), erythro, and threo compounds. Optical purity, prochirality, enantiotopic and diastereotopic atoms, groups, faces, axial and planar chirality, Asymmetric synthesis, Cram's and Prelog's rules.

Geometrical isomerism. E, Z nomenclature of olefins, Geometrical and optical isomerism (if shown) of disubstituted cyclopropane, cyclobutane and cyclopentanes.

#Chiral shift reagents and chiral solvating reagents. Criteria for optical purity: Resolution of racemic modifications, asymmetric transformations, Asymmetric synthesis, destruction. Stereoselective and stereospecific synthesis#.

Unit – V Stereochemistry-II: (18 Hours)

Conformation and conformational analysis: Conformation and reactivity in acyclic systems conformations of some simple 1,2-disubstituted ethane derivatives. Sawhorse and Newmann projections. Curtin-Hammett Principle.

Conformational analysis of disubstituted cyclohexane and Conformation and reactivity of substituted cyclohexanol (oxidation and acylation), cyclohexanone (reduction), and cyclohexane carboxylic acid derivatives (esterification and hydrolysis). Newmann projection of cyclohexane and decalins. Conformation and stereochemistry of decalins. Brett's rule.

Optical rotation and optical rotatory dispersion, conformational asymmetry, ORD curves, octant rule, configuration, and conformation. Cotton effect, axial halo ketone rule, and determination of configuration.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. P. S. Kalsi, Stereochemistry of carbon compounds, 8th edition, New Age International Publishers, 2015.

2. Ernest L. Eliel, Stereochemistry of carbon compounds, Tata McGraw-Hill Edition, 2001.

3. P. Y. Bruice, Organic Chemistry, 7th edition, Prentice Hall, 2013.

4. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th edition, Pearson Education, 2010.

5. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd edition, New Age Publishers, 2005.

6. A Textbook of Organic Chemistry – Volume 1 / Mandeep Dalal (First Edition, 2019) Copyright © 2019 by Mandeep Dalal.

7. V. K. Ahluwalia, Organic Reaction Mechanisms, 4th edition, Narosa Publishing House, 2020.

8. S.M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition, Trinity Press, New Delhi, 2015.

Reference Books:

1. I. L. Finar, Organic Chemistry Vol. I & Vol. II, Longman (Cambridge), 2011.

2. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th edition, 2001.

3. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry Part-A and B, 5th edition, Kluwer Academic / Plenum Publishers, 2007.

4. M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th edition, 2001.

5. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd edition, 2014.

6. S. H. Pine, Organic Chemistry, 5th edition, McGraw Hill International Edition, 1987.

e-Resources:

1. https://bit.ly/3zT4PUq
2. https://www.organic-chemistry.org/
3. https://www.studyorgo.com/summary.php
4. https://www.clutchprep.com/organic-chemistry
5. https://nptel.ac.in/
6. https://swayam.gov.in

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	2	3	-	3	-	-	2	3	2	3
CO2	3	3	3	-	2	-	-	3	3	3	2
CO3	2	3	3	-	2	-	-	2	2	2	3
CO4	3	2	2	-	2	-	-	3	3	3	2
CO5	3	3	3	-	2	-	-	2	2	2	2
	2.6	**2.6**	**2.8**	**-**	**2.2**	**-**	**-**	**2.4**	**2.6**	**2.4**	**2.4**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. S. SHEIK MANSOOR	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*CC*	***P24MCH102***	***STRUCTURE AND BONDING IN INORGANIC COMPOUNDS***	***90***	***5***	***25***	***75***	***100***

Objectives:

- To study the structural properties of main group compounds and clusters.
- To gain fundamental knowledge of the structural aspects of ionic crystals.
- To familiarize various diffraction and microscopic techniques.
- To study the effect of point defects and line defects in ionic crystals. To evaluate the structural aspects of solids.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Predict the geometry of main group compounds and clusters.	**K3**
CO2	Explain the packing of ions in crystals and apply the radius ratio rule to predict the coordination number of cations.	**K2**
CO3	Analyze the various types of ionic crystal systems and their structural features and to explain the crystal growth methods.	**K4**
CO4	Explain the XRD data and applications of electron microscopic techniques for structure determination.	**K2**
CO5	Appraise the band theory of solids and defects in crystal systems.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Structure of main group compounds and clusters: (18 Hours)

VB theory - Effect of lone pair and electronegativity of atoms (Bent's rule) on the geometry of the molecules; Structure of silicates - applications of Pauling's rule of electrovalence - isomorphous replacements in silicates - ortho, meta, and pyro silicates - one dimensional, two dimensional and three-dimensional silicates. Structure of silicones, Structural and bonding features of B-N, S-N, and P-N compounds.

Poly acids - types, structures of isopolyacids and heteropolyacids of molybdenum; Borane cluster: Structural features of closo, nido, arachano, and klado; carboranes, hetero and metalloboranes; Wade's rule to predict the structure of borane cluster, main group clusters - zintl ions and mno rule.

Unit – II Solid state chemistry – I: (18 Hours)

Ionic crystals: Packing of ions in simple, hexagonal, and cubic close packing, voids in a crystal lattice, Radius ratio rule, Crystal systems, and Bravais lattices, Symmetry operations in crystals, glide planes, and screw axis; point group and space group;

Solid state energetics: Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant.

Unit – III Solid state chemistry – II: (18 Hours)

Structural features of the crystal systems: Rock salt, zinc blende & wurtzite, fluorite and anti-fluorite, rutile and anatase, cadmium iodide and nickel arsenide; Spinels -normal and inverse types and perovskite structures.

Crystal Growth methods: From melt and solution (hydrothermal, sol-gel methods) – principles and examples.

Unit – IV Techniques in solid state chemistry: (18 Hours)

X-ray diffraction technique: Bragg's law, Powder diffraction method – Principle and Instrumentation; Interpretation of XRD data – JCPDS files, Phase purity, Scherrer formula, lattice constants calculation; Systematic absence of reflections; Electron diffraction technique – principle, instrumentation and application.

Electron microscopy – the difference between optical and electron microscopy, theory, principle, instrumentation, sampling methods, applications of SEM and TEM.

Unit – V Band theory and defects in solids: (18 Hours)

Band theory – features and its application to conductors, insulators and semiconductors, Intrinsic and extrinsic semiconductors.

Defects in crystals – point defects (Schottky, Frenkel, metal excess and metal deficient) and their effect on the electrical and optical property, laser and phosphors; Linear defects and their effects due to dislocations.

Text Books:

1. A. R. West, Solid-state Chemistry and its applications, 2nd edition (Students Edition), John Wiley & Sons Ltd., 2022.

2. A. K. Bhagi and G R Chatwal, A textbook of inorganic polymers, Himalaya Publishing House, 2001.

3. L. Smart, E Moore, Solid State Chemistry – An Introduction, 4th edition, CRC Press, 2019.

4. D. K. Chakrabarty, Solid State Chemistry, 2nd edition, New Academic Science Publishers, 2010.

5. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, 4th edition, Harper and Row, NewYork, 1993.

Reference Books:

1. D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd edition, John Wiley & Sons, 2006.

2. R J D Tilley, Understanding Solids - The Science of Materials, 3rd edition, Wiley Publication, 2021.

3. Atkins, Overton, Rourke, Weller, Armstrong, and Hagerman, Shriver & Atkins' Inorganic Chemistry; 5th edition, Oxford University Press, London, 2010.

4. C N R Rao and J Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition, Cambridge University Press, 1999.

5. Catherine E Housecraft and Alan G Sharpe, Inorganic Chemistry, 3rd edition, Pearson Publishers, UK, 2008.

e-Resources

1. Lecture Videos | Introduction to Solid-State Chemistry | Materials Science and Engineering | MIT Open Course Ware.
2. NPTEL: Chemistry and Biochemistry - NOC: Solid State Chemistry.
3. The Oxford Solid State Basics | University of Oxford Podcasts.
4. NPTEL: Chemistry and Biochemistry - NOC: Chemistry of Main Group Elements.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	3	3	-	3	-	-	3	3	3	3
CO2	3	3	3	-	2	-	-	2	3	3	3
CO3	3	3	3	-	2	-	-	2	3	3	3
CO4	3	3	3	-	3	-	-	3	3	3	3
CO5	3	3	3	-	3	-	-	3	3	3	3
	2.8	**3**	**3**	**-**	**2.6**	**-**	**-**	**2.6**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. Z. ANSAR ALI	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*CC*	***P24MCHP11***	***ORGANIC CHEMISTRY PRACTICALS - I***	***90***	***5***	***25***	***75***	***100***

Objectives:

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

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Recall the basic principles of organic separation, qualitative analysis, and preparation.	**K1**
CO2	Explain the method of separation and analysis of separated organic mixtures and convert them as derivatives by suitable preparation methods.	**K3**
CO3	Determine the characteristics of the separation of organic compounds by various chemical reactions.	**K5**
CO4	Develop strategies to separate, analyze, and prepare organic compounds.	**K5**
CO5	Formulate a method of separation, analysis of organic mixtures, and design suitable procedures for organic preparations.	**K6**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Separation and Analysis:

A. Two component mixtures.

B. Three component mixtures.

Unit – II Estimations:

a) Estimation of Phenol (Bromination)
b) Estimation of Aniline (Bromination)
c) Estimation of Ethyl methyl ketone (Iodimetry)
d) Estimation of Glucose (Redox)
e) Estimation of Ascorbic acid (Iodimetry)
f) Estimation of Aromatic nitro groups (Reduction)
g) Estimation of Glycine (Acidimetry)
h) Estimation of Formalin (Iodimetry)
i) Estimation of Acetyl group in ester (Alkalimetry)
j) Estimation of Hydroxyl group (Acetylation)
k) Estimation of Amino group (Acetylation)

Unit – III Two stage preparations:

a) p-Bromoacetanilide from aniline
b) p-Nitroaniline from acetanilide
c) 1,3,5-Tribromobenzene from aniline
d) Acetyl salicylic acid from methyl salicylate
e) Benzilic acid from benzoin
f) m-Nitroaniline from nitrobenzene
g) m-Nitrobenzoic acid from methyl benzoate

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Lab Manual, S. Viswanathan Co. Pvt. Ltd, 2009.

2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry, S. Chand and Co., 2011.

Reference Books:

1. Vogel's Textbook of Practical Organic Chemistry, 5th edition, ELBS/Longman, England, 2003.

e-Resources:

1. https://bit.ly/3tMt2YQ

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	2	2	1	-	2	-	-	3	3	3	3
CO2	3	2	2	-	2	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	3	3	3
CO4	3	3	3	-	3	-	-	3	3	3	3
CO5	3	3	3	-	3	-	-	3	3	3	3
	2.8	**2.6**	**2.4**	**-**	**2.6**	**-**	**-**	**3**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. S. SHEIK MANSOOR	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*DSEC*	***P24ECH101***	***ELECTRO AND PHOTOCHEMISTRY (ELECTIVE - I)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To study the behavior of electrolytes in solution and compare the structures of electrical double layers of different models.
- To have knowledge of storage devices and electrochemical reaction mechanisms.
- To understand the Basic concepts of Photochemistry.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Explain the behavior of electrolytes in solution**.**	**K4**
CO2	Predict the structures of electrical double layers of different models and describe the concept of the electro-kinetic phenomena with regard to colloidal and poly electrolytes.	**K5**
CO3	Apply the concepts of electrochemistry for the study of Electrodics, Corrosion, and Fuel cells.	**K2**
CO4	Describe the various photophysical and photochemical processes.	**K4**
CO5	Evaluate quantum yield, to predict the mechanism, to arrive the rate equation of photochemical reaction, and to explain laser action.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Ionics: (15 Hours)

Concept of ionic strength, Ionic activity, mean ionic activity and mean ionic activity coefficient-Activity coefficient of strong electrolytes, Determination of activity coefficient by Electrochemical method. Concept of ion-solvent and ion-ion interactions. Born Model.

Debye-Huckel limiting law - Derivation - Qualitative and Quantitative verification - Debye-Huckel limiting law at an appreciable concentration of electrolytes - modifications and applications.

Debye-Huckel Onsager theory of strong electrolyte - Concept for ionic atmosphere - Debye-Huckel Onsager equation, verification and limitations.

Debye-Huckel Bjerrum model of ion association: Concept of ion-pair formation and triple ion formations. Effect of ion association on conductivity.

Unit – II Electrode-electrolyte interface: (15 Hours)

Interfacial phenomena - Evidence for electrical double layer, polarizable and non-polarizable interfaces, Electrocapillary phenomena - Lippmann equation electro capillary curves.

Structure of double layer: Helmholtz -Perrin, Guoy- Chapman and Stern models of electrical double layer.

Electro-kinetic phenomena: Electro-osmosis, electrophoresis, streaming and sedimentation potentials, colloidal and poly electrolytes.

Zeta potential and potential at zero charge. Applications and limitations.

Unit – III Electrodics & Kinetics of Electrode Reactions: (15 Hours)

Factors affecting the rate of electrochemical reaction; Nernst equation, polarizable and non-polarizable electrodes. Concept of overpotential and their types: Chemical and electrochemical phase activation and concentration over potential.

Butler-Volmer equation – for one electron and multi-electron transfer reactions - the significance of exchange current density, net current density, and transfer coefficient Tafel equations and Tafel plots.

Mechanism of oxygen and hydrogen evolution reaction – Corrosion and Passivation of Metals. Pourbiax and Evan's diagrams.

Fuel Cells: H_2-O_2 fuel cells, alkaline fuel cells, phosphoric acid fuel cells, and high-temperature fuel cells.

Unit – IV Photochemistry – I: (15 Hours)

Thermal and Photochemical reaction - Decay of electronically excited state; Jablonski Diagram – Radiative and Nonradiative transitions.

Luminescence: Fluorescence – mechanism, structural dependence on fluorescence, Types, and Quenching of fluorescence. Phosphorescence: Triplet state and phosphorescence emission – Heavy atom effect – comparison of fluorescence and phosphorescence.

Photophysical kinetics of the unimolecular process, Quenching: Static, Dynamic and Chemical Quenching. Kinetics of Collisional Quenching: Derivation of Stern – Volmer equation and its application. Concentration Quenching – Excimer formation and emission.

Types of photochemical reaction: photo isomerization, photo reduction, photo substitution, and photosensitization.

Unit – V Photochemistry – II: (15 Hours)

Concept of Quantum yield: Primary and secondary process, Reasons for low and high quantum yield, Determination of quantum yield – Chemical Actinometry.

Concept of spontaneous and induced emission, Einstein Transition probability – Relationship between Einstein coefficients.

Lasers: population inversion, Characteristics, Mechanism, Examples of laser systems and Applications, study of photochemical reactions- flash photolysis method and applications.

Kinetics of photochemical Reactions: Decomposition of hydrogen iodide, H_2-Cl_2 reaction, H_2-Br_2 reaction, photolysis of acetaldehyde, and Dimerization of anthracene.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. D. R. Crow, Principles and applications of electrochemistry, 4th edition, Chapman & Hall/CRC, 2014.

2. J. Rajaram and J.C. Kuriakose, Kinetics and Mechanism of Chemical Transformations, Macmillan India Ltd., New Delhi, 2011.

3. S. Glasstone, Electrochemistry, Affiliated East-West Press, Pvt., Ltd., New Delhi, 2008.

4. B. Viswanathan, S. Sundaram, R. Venkataraman, K. Rengarajan and P.S. Raghavan, Electrochemistry-Principles and applications, S. Viswanathan Printers, Chennai,2007.

5. Joseph Wang, Analytical Electrochemistry, 2nd edition, Wiley, 2004.

6. Turro N.J., Modern molecular photochemistry, Benjamin, Cumming Mento Park, University Science Books, 1991.

Reference Books:

1. J. O. M. Bockris and A. K. N. Reddy, Modern Electrochemistry, vol.1 and 2B, Springer, Plenum Press, New York, 2008.

2. J. O. M. Bockris, A. K. N. Reddy and M. G. Aldeco Morden Electro chemistry, vol. 2A, Springer, Plenum Press, New York, 2008.

3. Philip H. Rieger, Electrochemistry, 2nd edition, Springer, New York, 2010.

4. L. I. Antropov, Theoretical Electrochemistry, Mir Publishers, 1977.

5. K. L. Kapoor, A Textbook of Physical Chemistry, volume-3, Macmillan, 2001.

6. Wayne R. P., Photochemistry, Butterworths, London, 1970.

e-Resources:

Activity and Activity Coefficient: https://youtu.be/ePUP0WLXHFI

Debye Huckel Theory:1. https://youtu.be/TqTiqPj94TU
2. https://youtu.be/3jav0EMWU6w
3. https://youtu.be/45Wg9aBrOxU
4. https://youtu.be/Kg8wuqgcSLI
5. https://youtu.be/VA4b_pBDd7c

Photochemistry: 1. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/photchem.htm
2. https://courseware.cutm.ac.in/wp-content/uploads/2020/05/Kinetics_of_photochemical_reactions.pdf

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	-	-	2	3	3	3
CO2	3	3	2	-	-	-	-	2	3	3	3
CO3	3	3	3	-	-	-	-	2	3	3	3
CO4	3	3	1	-	-	-	-	2	3	3	1
CO5	3	3	3	-	-	-	-	2	3	3	3
	3	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**2.6**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. M. S. M. KAMIL	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*DSEC*	***P24ECH103***	***INORGANIC PHOTOCHEMISTRY (ELECTIVE - I)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To know the basics of photochemistry.
- To describe and explain the photochemical and photophysical processes of metal complexes.
- To understand the applications of metal complexes in photochemistry.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	**CO Statement** (On the successful completion of the course, the students will be able to)	**Cognitive Level**
CO1	Define and explain the basic principles concerning photochemistry.	**K2**
CO2	Compare the excited states of metal complexes with organic molecules.	**K3**
CO3	Analyze the different types of photochemical reactions based on energy states.	**K4**
CO4	Evaluate the mechanism of redox reactions in excited metal complexes.	**K5**
CO5	Discuss the applications of metal complexes as sensitizers.	**K2**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Basics of Photochemistry: (15 Hours)

Absorption, excitation, photochemical laws, quantum yield, electronically excited states, life times-measurements of the times. Flash photolysis, energy dissipation by radiative and non-radiative processes, absorption spectra, Frank-Condon principle, photochemical stages-primary and secondary processes.

Unit – II Excited States of Metal Complexes: (15 Hours)

Excited states of metal complexes: Comparison with organic compounds, electronically excited states of metal complexes, charge transfer spectra, and charge transfer excitations.

Unit – III Ligand Field Photochemistry: (15 Hours)

Photo substitution, photo-oxidation, and photo-reduction, lability and selectivity, zero vibrational levels of the ground state and the excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states.

Unit – IV Redox Reactions by Excited Metal Complexes: (15 Hours)

Energy transfer under conditions of weak interaction and strong interaction-examples formation; condition of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates, (2,2-bipyridine and 1,10-phenanthroline complexes), illustration of reducing and oxidizing character of Ruthenium+2 (bipyridyl complex, comparison with Fe (bipy); role of spin-orbit coupling-life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, a transformation of low energy reactants into high energy products, chemical energy into light.

Unit – V Metal Complex Sensitizers: **(15 Hours)**

Metal complex sensitizer, electron relay, metal colloid systems, semiconductor-supported metal or oxide systems, water photolysis, nitrogen fixation, and carbon dioxide reduction.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. Arun Singh Negi, Introduction to Inorganic Photochemistry, CyberTech Publications, 2011.
2. A.W. Adamson and P.D. Fleischauer, Concepts of Inorganic Photochemistry, Wiley, 1975.
3. Inorganic Photochemistry, J. Chem. Educ. vol. 60 No. 10, 1983.
4. Stephen J. Lippard, Progress in Inorganic Chemistry, Vol. 30, 1st edition, Wiley, 1983.
5. K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, Wiley, New York, 3rd edition, 2002.

Reference Books:

1. Elements of Inorganic Photochemistry, G. J. Ferraudi, John Wiley & Sons, 1988.
2. Turro, N. J., Modern Molecular Photochemistry, Benjamin-Cummings, NY, 1978.
3. Photochemistry of Coordination Compounds, V. Balzari and V. Carassiti, Academic Press.
4. S. Arunachalam, Inorganic Photochemistry-An Introduction to Photochemical and Photophysical Aspects of Metal Complexes, Kala Publications, Tiruchirappalli, India, 2002.
5. D.M. Roundhill, Photochemistry and photophysics of Metal complexes, Springer Edition, 1994.

e-Resources:

1. https://nptel.ac.in/
2. https://swayam.gov.in
3. https://bit.ly/3OtepkR

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	-	2	-	-	2	3	3	2
CO2	3	3	2	-	3	-	-	3	3	2	3
CO3	2	3	3	-	3	-	-	3	3	2	3
CO4	3	3	2	-	2	-	-	3	2	3	3
CO5	3	3	3	-	3	-	-	2	3	2	3
	2.8	**2.8**	**2.6**	**-**	**2.6**	**-**	**-**	**2.6**	**2.8**	**2.6**	**2.8**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. A. AHMED RAZA	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*DSEC*	***P24ECH102***	***GREEN CHEMISTRY (ELECTIVE - II)***	***75***	***3***	***25***	***75***	***100***

Objective:

- To discuss the principles of green chemistry.
- To minimize the environmental impact of industrial solvents.
- To prevent or reduce pollution.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Explain the basic principles of green chemistry.	**K2**
CO2	Discuss the various green solvents used in chemical industries and in the laboratories.	**K2**
CO3	Examine the advantages of organic reactions assisted by green catalysts.	**K4**
CO4	Apply the principles of PTC in green reactions.	**K3**
CO5	Analyze the organic compounds synthesized by microwave and ultrasound-assisted method.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I **(15 Hours)**

Introduction- Need for Green Chemistry. Goals of Green Chemistry. Green chemistry in day-to-day life. Limitations of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations, and Twelve Principles of Green Chemistry – Atom economy reactions – rearrangement, addition reactions – atom uneconomic reactions- substitution, elimination reaction.

Unit – II **(15 Hours)**

Choice of starting materials, reagents, catalysts, and solvents in detail, Designing green synthesis-green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids-criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks, and a few examples of organic reactions in CO_2. Green synthesis-adipic acid and catechol.

Unit – III **(15 Hours)**

Environmental pollution, Green Catalysis-Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts - Polystyrene aluminum chloride, polymeric super acid catalysts, Polymer supported photosensitizers – Carbon footprinting

Unit – IV **(15 Hours)**

Phase transfer catalysis in green synthesis- mechanism, types, and advantages - oxidation using hydrogen peroxide, crown ethers-esterification, saponification, anhydride formation, Elimination reaction, and Displacement reaction. Applications in organic synthesis.

Unit – V **(15 Hours)**

Microwave-induced green synthesis-Introduction, Principle and Applications. Microwave-assisted reaction in water and organic solvents. Sonochemistry – Instrumentation, Cavitation theory - Ultrasound assisted green synthesis and Applications.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self-study component in the End Semester Examinations)

Text Books:

1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.

2. W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 7thedition, McGraw-Hill, NewDelhi,2005.

3. J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall,1974.

4. V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi,2001.

5. A. K. De, Environmental Chemistry, New Age Publications, 2017.

Reference Books:

1. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998

2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001

3. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000

4. Ryan, M.A. and Tinnes and, M., Introduction to Green Chemistry, American Chemical Society Washington, 2002.

5. Chandrakanta Bandyopadhyay, An Insight into Green Chemistry, Books and Allied (P) Ltd, 2019.

e-Resources:

1. https://www.organic-chemistry.org/
2. https://www.studyorgo.com/summary.php

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	-	-	3	3	3	3	3	1
CO2	3	3	3	-	-	3	3	3	2	3	3
CO3	3	3	3	-	-	3	3	3	3	3	3
CO4	3	3	3	-	-	3	3	3	3	3	3
CO5	3	3	3	-	-	3	3	3	3	3	3
	3	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**2.8**	**3**	**2.6**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. Z. ABDUL VAHEITH	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
I	*DSEC*	***P24ECH104***	***MEDICINAL CHEMISTRY (ELECTIVE - II)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To study the chemistry behind the development of pharmaceutical materials.
- To gain knowledge on the mechanism and action of drugs.
- To understand the need for antibiotics and the usage of drugs.
- To familiarize with the mode of action of diabetic agents and treatment of diabetes.
- To identify and apply the action of various antibiotics.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Understand the concept of medicinal chemistry, isomerism, and its nomenclature.	**K2**
CO2	Predict the properties of a drug based on its structure.	**K5**
CO3	Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.	**K3**
CO4	Discuss the relationship between the drug's chemical structure and its therapeutic properties.	**K2**
CO5	Develop the different targets for the identification of new drugs for the treatment of infectious and GIT.	**K6**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Introduction to Medicinal Chemistry: (15 Hours)

History and development of medicinal chemistry, Physicochemical properties in relation to biological action, Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism. Drugs: Essential Drugs, Nomenclature of Drugs, Routes of Drug Administration, Adverse Effects of Drugs, IUPAC Naming of Drugs.

Unit–II Introduction to Receptors: (15 Hours)

Introduction, targets, Agonist, antagonist, partial agonist. Receptors, Receptor types, Theories of Drug– receptor interaction, Drug synergism, Drug resistance, and physicochemical factors influencing drug action.

Unit – III Antibiotics: (15 Hours)

Introduction, Targets of antibiotics action, classification of antibiotics, enzyme-based mechanism of action, SAR of penicillins and tetracyclin's, clinical application of penicillins, cephalosporin.Current trends in antibiotic therapy.

Unit – IV Antihypertensive agents and diuretics: (15 Hours)

Classification of cardiovascular agents, introduction to hypertension, etiology, types, classification of antihypertensive agents, classification and mechanism of action of diuretics, Furosemide, Hydrochlorothiazide, and Amiloride.

Unit – V Analgesics, Antipyretics and Anti-inflammatory Drugs: (15 Hours)

Introduction, Mechanism of inflammation, classification, and mechanism of action and paracetamol, Ibuprofen, Diclofenac, naproxen, indomethacin, phenylbutazone, and meperidine.

Medicinal Chemistry of Antidiabetic Agents Introduction, Types of diabetics, Drugs used for the treatment, chemical classification, Mechanism of action, Treatment of

diabetic mellitus. Chemistry of insulin, sulfonylurea.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. Foye's Principles of Medicinal Chemistry, 7th Edition, by David A. Williams and Thomas L. Lemke, Lippincott Williams & Wilkins, 2012.

2. Burger's Medicinal Chemistry, Drug Discovery, and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic Press, 2010.

3. The Organic Chemistry of Drug Design and Drug Action, by Richard B. Silverman, 2nd Edition. Elsevier Academic Press, 2004, ISBN 0-12-643732-7.

4. O. LeRoy, Natural and synthetic organic medicinal compounds, Ealemi, 1976.

5. S. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Limited, New Delhi, 1993, New edition.

Reference Books:

1. Medicinal Chemistry, An Introduction, by Gareth Thomas, John Wiley & Sons, 2000.

2. The Practice of Medicinal Chemistry, ed. Camille Wemuth, Academic Press, 1996.

3. P. Parimoo, A Textbook of Medical Chemistry, New Delhi: CBS Publishers.1995.

4. S. Ramakrishnan, K. G. Prasannan and R. Rajan, Textbook of Medical Biochemistry, Hyderabad: Orient Longman. 3rd edition, 2001.

e-Resources:

1. https://www.classcentral.com/course/swayam-medicinal-chemistry12908

2. https://www.ncbi.nlm.nih.gov/books/NBK482447/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	-	2	-	-	3	3	3	2
CO2	3	3	2	-	2	-	-	2	3	2	2
CO3	3	2	2	-	2	-	-	3	3	3	3
CO4	3	3	2	-	2	-	-	2	3	3	3
CO5	3	3	3	-	3	-	-	3	3	2	3
	3	**2.6**	**2.4**	**-**	**2.2**	**-**	**-**	**2.6**	**3**	**2.6**	**2.6**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. A. AHMED RAZA	Dr. S. ZAHEER AHMED

Sem	Category	Course Code	Course Title	Hours	Credits	Int. Marks	Ext. Marks	Max. Marks
II	CC	P24MCH201	ORGANIC REACTION MECHANISM – II	90	5	25	75	100

Objectives:

- To learn the various types of reactions, rearrangements, and their synthetic utility.
- To understand the mechanism involved in various types of organic reactions with evidences.
- To understand the applications of synthetically important reagents.
- To understand various types of oxidation and reduction reactions along with their mechanism and synthetic utility.
- To design synthetic routes for synthetically used organic reactions.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Discuss the basic principles of addition to C=C and C=O bonds.	K2
CO2	Correlate the principles of elimination, addition reactions and free radicals.	K4
CO3	Examine the multiple ways to use oxidation and reduction reactions in synthesis.	K4
CO4	Identify the mechanism of various molecular rearrangement reactions.	K3
CO5	Predict the suitable reagents for the conversion of selective organic compounds.	K4

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Addition to Carbon Multiple Bonds: (18 Hours)

Addition to carbon-carbon multiple bonds: Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes, and cyclic mechanisms -Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen.

Addition to carbon-heteroatom multiple bonds: Mannich reaction, acids, esters, nitrites, the addition of Grignard reagents, Wittig reaction, Prins reaction.

Stereochemical aspects of addition reactions. Addition of Grignard reagents - organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates – Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

Unit – II Elimination and Free Radical Reactions: (18 Hours)

Mechanisms: E1, E2, and E1CB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination.

Long-lived and short-lived radicals – Production of radicals by thermal and photochemical reactions – Ullmann reaction, Sandmeyer reaction, Gomberg Backmann reaction, Hundiecker reaction, Pshorr reaction, Detection and stability of radicals, #Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent#.

Unit – III Oxidation and Reduction Reactions (18 Hours)

Mechanisms: Direct electron transfer, hydride transfer, hydrogen-atom transfer, formation of ester intermediates, displacement, addition-elimination, oxidative and reductive coupling reactions.

Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate, lead tetraacetate, permanganate, manganese dioxide, osmium tetroxide, oxidation of saturated hydrocarbons, alkyl groups, alcohols, halides and amines. Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromium trioxide-pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey-Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCC).

Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, McFadyen-Steven's reduction, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.

Unit – IV Rearrangements: (18 Hours)

Rearrangements to electron-deficient carbon: Pinacol-pinacolone and semi-pinacolone rearrangements - applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Baker-Venkataraman, Benzilic acid and Wolff rearrangements.

Rearrangements to electron-deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements.

Rearrangements to electron-deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements.

Rearrangements to electron-rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement.

Intramolecular rearrangements – Claisen, abnormal Claisen, Cope, oxy-Cope Benzidine rearrangements.

Unit – V Reagents and Modern Synthetic Reactions: (18 Hours)

Lithium diisopropylamine (LDA), Azobisisobutyronitrile (AIBN), Sodium cyanoborohydride (NaBH3CN), meta-Chloroperbenzoic acid (m-CPBA), Dimethyl aminiopyridine (DMAP), n-Bu3SnD, Triethylamine (TEA), Diazobicyclo[5.4.0]undec-7-ene (DBU), Diisopropylazodicarboxylate (DIAD), Diethylazodicarboxylate (DEAD), N-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Tetramethyl piperiridin-1-oxyl (TEMPO), Phenyltrimethylammonium tribromide (PTAB).

Diazomethane and Zn-Cu, Diethyl maleate (DEM), Copper diacetylacetonate ($Cu(acac)_2$), $TiCl_3$, $NaIO_4$, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. S.M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition, Trinity Press, New Delhi, 2015.

2. V. K. Ahluwalia, Organic Reaction Mechanisms, 4th edition, Narosa Publishing House, 2020.

3. R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, 1993.

4. Modern Methods of Organic Synthesis, W Carruthers and Iain Coldham,4th edition, Cambridge University Press, 2004.

5. T.L. Gilchrist and C.W. Rees, Carbenes, Nitrenes and Arynes, Thomas Nelson and Sons Ltd., London.

6. V. K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 1st edition, 2012.

7. V. K. Ahluwalia, Reduction in Organic Synthesis, CRC Press, 1st edition, 2012.

8. A Textbook of Organic Chemistry – Volume 1 / Mandeep Dalal (1st Edition, 2019) Copyright © 2019 by Mandeep Dalal.

Reference Books:

1. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th edition, 2001.

2. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry Part-A and B, 5th edition, Kluwer Academic / Plenum Publishers, 2007.

3. M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th edition, 2001.

4. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd edition, 2014.

5. M. B. Smith, Organic Synthesis, Academic Press, 3rd edition, 2011.

6. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, 7th edition, Pearson Education, 2010.

e-Resources

1. https://bit.ly/3zT4PUq
2. https://www.organic-chemistry.org/
3. https://www.studyorgo.com/summary.php
4. https://www.clutchprep.com/organic-chemistry
5. https://nptel.ac.in/
6. https://swayam.gov.in

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	-	-	3	3	3	2
CO2	3	3	2	-	2	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	2	3	3
CO4	3	3	3	-	3	-	-	3	2	3	3
CO5	3	3	3	-	2	-	-	3	3	3	3
	3	**2.8**	**2.6**	**-**	**2.4**	**-**	**-**	**3**	**2.6**	**3**	**2.8**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. S. SYED TAJUDEEN	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*CC*	***P24MCH202***	***PHYSICAL CHEMISTRY- I***	***75***	***4***	***25***	***75***	***100***

Objectives:

- To recall the fundamentals of thermodynamics and the composition of partial molar quantities.
- To understand the classical and statistical approach of the thermodynamic functions
- To compare the significance of Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein
- To correlate the theories of reaction rates for the evaluation of thermodynamic parameters.
- To study the mechanism and kinetics of reactions.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	**CO Statement** (On the successful completion of the course, the students will be able to)	**Cognitive Level**
CO1	Explain the concept of chemical potential, fugacity, activity, and activity coefficient**.**	**K2**
CO2	Interpret and validate the concepts of statistical thermodynamics in terms of various thermodynamic functions and to compare classical and Quantum statistics.	**K5**
CO3	Apply the concepts of statistics to heat capacity of solids, gases, and basic concepts of irreversible thermodynamics.	**K4**
CO4	Apply the thermodynamics concepts to study the kinetics and reactions in solutions.	**K3**
CO5	Describe the mechanism of Homogeneous, Heterogeneous, and complex reactions.	**K2**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Thermodynamics of Open and Non-ideal Systems: (15 Hours)

Partial Molar Properties: Concept and Physical Significance of Partial Molar Properties, Determination of Partial Molar Properties – Method of Intercepts.

Chemical Potential: Chemical potential and its physical significance – Gibbs-Duhem equation. Variation of chemical potential with temperature and pressure. Chemical Potential of a System of Ideal Gases – Applications of Chemical Potential – Henry's Law, Nernst Distribution Law, and Raoult's Law.

Fugacity: Concept and Determination of fugacity of real gases by graphical method – Variation of fugacity with temperature and pressure – Lewis Randal rule – Duhem-Margules equation.

Activity and Activity Coefficient: Concept and Determination of activity and activity coefficient of non-electrolyte (emf method) – Choice of Standard State.

Unit – II Statistical Thermodynamics – I: (15 Hours)

Objectives of Statistical Thermodynamics, Concept of Energy levels and Energy States, Microstates and Macrostates – Distribution of Particles (Distinguishable and indistinguishable particles) in Energy Levels. Ensembles and their types.

Concept of mathematical and thermodynamic probabilities, the relationship between entropy and thermodynamic probability. Calculation of Thermodynamic Probability (W) for Distinguishable and indistinguishable particles with and without restriction on occupations.

Fundamental Postulates of Statistical Thermodynamics, Stirling's approximation, Classical statistics - Derivation of Maxwell-Boltzmann (MB) statistics - Quantum statistics: Derivation Bose-Einstein (BE), and Fermi-Dirac (FD) statistics– Comparison of Classical and Quantum statistics.

Partition Functions-Translational, rotational, vibrational, and electronic partition functions. Calculation of thermodynamic parameters – Pressure P, Internal Energy U, Entropy S, Enthalpy H, Gibbs function G, Helmholtz function A, and Equilibrium constant K) in terms of the partition function.

Unit – III Applications of Statistical Thermodynamics and Irreversible Thermodynamics: (15 Hours)

Applications of the partition function to heat-capacity of ideal monoatomic and diatomic gases.

Heat capacity of solids – Assumptions, Derivation and Limitations of Einstein and Debye models – Comparative study of Einstein's and Debye Theories.

Basic concepts of Irreversible Thermodynamics – Forces and fluxes – Phenomenological equations – Heat Transfer: Fourier's Law, Mass Transfer: Fick's Law, Momentum Transfer: Newton's Laws and Flow of Electricity: Ohm's Law.

Onsager Theory – Validity and verification – Principle of microscopic reversibility, Onsager reciprocal relations.

Unit – IV Chemical Kinetics-I: (15 Hours)

ARRT: Thermodynamics formulation of CTST – Eyring equation and its modification – Estimation of free energy, enthalpy, and entropy of activation and their significance. Problems related to the calculation of $\Delta G^{\neq}$, $\Delta S^{\neq}$, K_r.

Reactions in solutions: Effect of solvation on reaction rate, Effect of ionic strength – Salt effect – Jerrum-Bronsted equation. Effect of dielectric constant – Electrostriction – Scatchard equation. Effect of hydrostatic pressure on reaction rate – Concept of $\Delta V^{\neq}$

Acid-Base Catalysis: Mechanism of acid-base catalysis – Protolytic and prototropic mechanism. Catalytic activity and Acid-Base Strength – Bronsted catalysis law.

Unit – V Chemical Kinetics-II: (15 Hours)

Enzyme catalysis: Kinetics – Michaelis – Menton equation. Determinations of K_M and its significance.

Adsorption isotherms: Langmuir isotherm- competitive adsorption- adsorption coefficient. BET isotherm and applications.

Mechanism of heterogeneous catalysis- Langmuir-Hinshelwood and Langmuir-Rideal mechanism. Kinetics of unimolecular surface reactions.

Complex Reactions: Kinetics of parallel, consecutive, and Reversible reactions – Examples.

Chain reactions: General treatment of chain reactions – Ortho – Para hydrogen conversion and Thermal reaction between H_2-Cl_2 and H_2-Br_2. Rice – Herzfeld mechanism: Thermal decomposition of Acetaldehyde – Rate expression for half, one, and one and a half order.

Branched-chain Reaction and Explosion: H_2 - O_2 reaction and lower, upper explosion limits.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition, S.L.N.Chand and Co., Jalandhar, 1986.

2. I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A. Benjamin Publishers, California, 1972.

3. M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi, 1995.

4. K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint - 2013.

5. J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation, Macmillan India Ltd, Reprint - 2011.

Reference Books:

1. D.A. Mcqurrie And J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi, 1999.

2. R.P. Rastogi and R.R. Misra, Classical Thermodynamics, Vikas Publishing, Pvt. Ltd., New Delhi, 1990.

3. S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, Macmillan Publishers, New York, 1974

4. K.B. Ytsiimiriski, "Kinetic Methods of Analysis", Pergamom Press,1996.

5. Gurdeep Raj, Phase rule, Goel Publishing House, 2011.

e-Resources:

Statistical Thermodynamics –1. https://youtu.be/u4yfj0D_pMA
2. https://youtu.be/1wEKtjr_cpw
3. https://youtu.be/FZjKmd5Z-d0
4. https://youtu.be/JiGhWNfAIBo
5. https://youtu.be/EhSDG-_pv8M
6. https://youtu.be/yUCHErDJnfQ
7. https://youtu.be/J9OBrRczBXc

Kinetics -
1. https://youtu.be/DRxTMCdsq1g
2. https://youtu.be/UFRLtJkrsyE
3. https://youtu.be/UdIuLywe_DY

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-	-	2	3	3	3
CO2	3	3	3	-	-	-	-	2	3	3	3
CO3	3	3	3	-	-	-	-	2	3	3	3
CO4	3	3	3	-	-	-	-	2	3	3	3
CO5	3	2	1	-	-	-	-	2	3	1	3
	3	**2.8**	**2.6**	**-**	**-**	**-**	**-**	**2**	**3**	**2.6**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. S. MOHAMMED SAFIULLAH	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*CC*	***P24MCHP21***	***INORGANIC CHEMISTRY PRACTICALS - II***	***75***	***4***	***25***	***75***	***100***

Objectives:

- To understand and enhance the visual observation as an analytical tool for the quantitative and qualitative estimation of ions.
- To prepare the various inorganic metal complexes.
- To train the students to improve their skill in estimating the amount of ion accurately present in the solution
- To estimate metal ions, present in the given solution accurately without using instruments.
- To analyze a mixture of four cations containing two common and two rare cations.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	**CO Statement** (On the successful completion of the course, the students will be able to)	**Cognitive Level**
CO1	Identify the cations present in a mixture of salts.	**K2**
CO2	Apply the principles of semi-micro qualitative analysis to categorize acid radicals and basic radicals.	**K3**
CO3	Acquire qualitative analytical skills by selecting suitable confirmatory tests and spot tests.	**K4**
CO4	Choose the appropriate chemical reagents for the detection of cations.	**K3**
CO5	Synthesize coordination compounds in good quality.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Analysis of a mixture of cations:

Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.

Group-I : W, Tl, and Pb.

Group-II : Se, Te, Mo, Cu, Bi, and Cd.

Group-III : Tl, Ce, Th, Zr, V, Cr, Fe, Ti, and U.

Group-IV : Zn, Ni, Co, and Mn.

Group-V : Ca, Ba and Sr.

Group-VI : Li and Mg.

Unit – II Preparation of metal complexes:

l) Preparation of tristhioureacopper(I)sulphate
m) Preparation of potassium trioxalatochromate(III)
n) Preparation of tetramminecopper(II) sulphate
o) Preparation of Reinecke's salt
p) Preparation of hexathioureacopper(I) chloridedihydrate
q) Preparation of cis-Potassium trioxalatodiaquachromate(III)
r) Preparation of sodium trioxalatoferrate(III)
s) Preparation of hexathiourealead(II) nitrate

Unit – III Complexometric Titration:

h) Estimation of zinc, nickel, magnesium, and calcium.
i) Estimation of a mixture of metal ions-pH control, masking, and demasking agents.
j) Determination of calcium and lead in a mixture (pH control).
k) Determination of manganese in the presence of iron.
l) Determination of nickel in the presence of iron.

Text Books:

1. A. Jeya Rajendran, Microanalytical Techniques in Chemistry: Inorganic Qualitative Analysis, United Global Publishers, 2021.

2. Nagaraj, Kamalesu, Snehal Lokhandwala and Nikhil M Parekh, Textbook of Semimicro Inorganic Qualitative Analysis, 1st Edition, Notion Press, 2023.

2. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis; 3rd edition., The National Publishing Company, Chennai, Reprint 2008.

Reference Books:

1. Jeffery G. H., Bassett J., Mendham J., and Denney R. C. Vogel's Textbook of Quantitative chemical analysis, 6th edition, Pearsons Education, 2004.

2. Kolthoff I. M., and Sandell E. B., Text Book of Qualitative Inorganic Analysis, 3rd edition, The Macmillan Company.

e-Resources:

1. https://bit.ly/3tMt2YQ
2. 4.1_MIS_and_NJS_Manual_for_Inorganic_semi-micro_qualitative_analysis.pdf (iscnagpur.ac.in)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	3	3	3	3
CO2	3	3	3	-	3	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	3	3	3
CO4	3	3	3	-	3	-	-	3	3	3	3
CO5	3	3	3	-	2	-	-	3	3	3	3
	3	**3**	**3**	**-**	**2.8**	**-**	**-**	**3**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. M.S.M. KAMIL	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*DSEC*	***P24ECH201***	***NANOMATERIALS AND NANOTECHNOLOGY (ELECTIVE - III)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To explore the fundamental ideas of Nanomaterials and Nanotechnology.
- To decipher the knowledge of physical, chemical, and green approaches of nanomaterials synthesis.
- To analyze and apply for designing new materials with multi-functional properties.
- To understand the fundamental principles, and concepts of material characterization.
- To enhance the knowledge of nanotechnology applications in various fields.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	**CO Statement** (On the successful completion of the course, the students will be able to)	**Cognitive Level**
CO1	Explain the elemental concept of nanomaterials and nanotechnology.	**K2**
CO2	Discuss the various synthetic methods of nanomaterials.	**K2**
CO3	Analyze the functional properties of materials such as electrical, optical, thermal, magnetic, and mechanical properties.	**K4**
CO4	Explore the nanomaterials using different characterization techniques for confirmation.	**K4**
CO5	Evaluate the applications of nanomaterials in different fields.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit – I: Basic Concepts of Nanoscience and Technology: (15 Hours)

Introduction of nanomaterials and nanotechnologies. Nanocrystals and behavior of nanomaterials. Features of nanostructures, Background of nanostructures. Classification of nanostructured materials- 0D, 1D, 2D, 3D different geometric configurations - nanowires, nanotubes, nanorods nanofluids, nanoemulsion, etc. Concept of bulk vs nanomaterials and dependence of properties on size. Introduction to top-down vs bottom-up approach of synthesis with suitable examples.

Unit – II: Synthesis routes of Nanomaterials: (15 Hours)

Chemical Synthesis: Sol-Gel process- self-assembly process, solvothermal and hydrothermal, Microwave-assisted, Electrochemical synthesis, and Photochemical Synthesis.

Physical Synthesis: Ball Milling- Inert Gas Condensation method, Arc discharge method, CVD-types- metallo organic, Plasma enhanced, and Low-pressure CVD.

Green and Biological synthesis - plants, bacteria, fungi, actinomycetes, and viruses for nanoparticle synthesis.

Designing of advanced integrated nanocomposites: Core-shell nanostructure, organic-inorganic hybrids, quantum dots (QDs), carbon nanotubes, and graphene nanosheets.

Unit – III: Properties of Nanomaterials: (15 Hours)

Structure and morphology of nanoparticles: Crystal structure of materials, packing fraction, basics of solid-state chemistry, specific surface energy and surface stress and effect on the lattice parameters. Nanoparticle morphology and morphology of supported particles.

Novel properties of nanomaterials: Size and shape-dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, and non-linear optical properties; transition metal sols, the origin of plasmon band, Mie theory, the influence of various factors on the plasmon absorption, catalytic properties.

Unit – IV: Tools to Characterize Nanomaterials: (15 Hours)

Structural Characterization: Spectroscopy- X-ray photoelectron spectrophotometer (XPS), Optical- Dynamic Light Scattering (DLS). #Thermal analysis- Differential Scanning Calorimeter (DSC), Thermogravimetric / Differential Thermal analyzer (TG/DTA). Microscopic analysis: Electron microscope- SEM, TEM, and AFM. Surface analysis- BET. Electrical, Mechanical, and Magnetic analysis- Impedance spectroscopy, Potentiometry, Cyclic voltammetry, Physical Property Measurement System (PPMS)#, Nanoindentation, Vibrating sample magnetometry.

Unit – V: Applications of Nanostructured Materials: (15 Hours)

Nanocomposites and their application, Metal-Metal nanocomposites for nuclear energy application, Magnetic nanocomposites for Spintronics application, Conducting polymers in corrosion protection, sensors, electronic and electrochemical energy devices, Ceramic nanocomposites for high-temperature application.

Miscellaneous application of nanomaterials- dental implants, consumer products, biomimetic nanomaterials for tissue engineering, biopolymer tagging, and semiconductor quantum dots.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. Text Book of Nanoscience and Nanotechnology, B. S. Murty, P. Shankar, Baldev Raj, B B Rath, and James Murday, Universities Press, 20.
2. Nano Materials, B. Viswanathan, Narosa Publishing House, 20.
3. Principles of Materials Science, S. Mohan and V. Arjunan, MJP Publishers, 2016.
4. Materials Science, Arumugam, Anuradha Publications, 2007.
5. Introduction to Materials Science for Engineers, James F. Shackelford and Madanapalli K. Muralidhara, 6th edition, PEARSON Press, 2007.
6. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press, (2004).

Reference Books:

1. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press, (2005).
2. Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth - Heinemann Publishers, (1992).
3. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005).
4. Introduction to Nanoscience, S. M. Lindsay, 1st edition, Oxford University Press, (2010).

e-Resources:

1. https://nptel.ac.in/courses/118/102/118102003/
2. https://nptel.ac.in/courses/118/104/118104008/
3. https://nptel.ac.in/courses/113/107/113107081/
4. https://www.classcentral.com/course/swayam-structural-analysis-of-nanomaterials-14310

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	3	-	3	-	-	2	3	3	3
CO2	3	3	2	-	2	-	-	3	2	3	3
CO3	3	3	3	-	3	-	-	2	3	3	2
CO4	2	3	3	-	3	-	-	2	3	3	3
CO5	2	3	2	-	2	-	-	2	2	3	3
	2.6	**2.8**	**2.6**	**-**	**2.6**	**-**	**-**	**2.2**	**2.6**	**3**	**2.8**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. S. KHALEEL BASHA	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*DSEC*	***P24ECH202***	***IMMUNOCHEMICAL AND FORENSIC ANALYSIS (ELECTIVE - III)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To impart knowledge on the principles and practical applications of various immunochemical and forensic analyses.
- To understand and perform immunological and forensic analyses using physical, biochemical, and instrumental methods of analysis.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Explain the general principles of antigen-antibody interactions. Know the methods of quantitative and qualitative analysis of antigens and antibodies.	**K2**
CO2	Apply the principles of immunodiffusion and immunoelectrophoresis.	**K3**
CO3	Formulate the principles and practical applications of ELISA and ELOSA.	**K6**
CO4	Estimate the fluorescence immunoassays like SLFIA, DELFIA, and FACS.	**K4**
CO5	Discuss the methods of forensic analysis and their importance.	**K2**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Antigen-Antibody Interactions: Principles and Applications: (15 Hours)

Principles of Antigen-antibody interactions: Strength of Antigen-Antibody Interactions- Zone of Equivalence and its significance in Analysis-Cross-Reactivity- Precipitation Reactions in fluid and gels- quantitative and qualitative analysis of antigen.

Hapten inhibition test: Haptens and their role in immunoassays – Hapten Inhibition test and its applications.

Immunodiffusion: Agglutination Reactions, Immunodiffusion - principles, single and double immunodiffusion-Cross-Reactivity.

Isotope dilution techniques: Principles and applications- radioisotope dilution techniques and applications.

Unit – II Immuno Analytical Techniques: (15 Hours)

ELISA & ELOSA: Principles of Enzyme-linked immunoassays – Types - Direct, Indirect, Sandwich and Competitive ELISA Techniques- Use of Chemiluminescence in ELISA – ELISPOT Assay.

Western Blotting: Principles, procedures, and applications.

Immunoprecipitation: Principles and their applications in the analysis of antigens.

Immunofluorescence: Substrate labelled fluorescent immunoassay (SLFIA)- Delayed enhanced lanthanide fluorescence immunoassay (DELFIA)- Flow cytofluorimetry and fluorescence-activated cell sorting (FACS)-Particle counting immunoassays (PACIA).

Unit – III Forensic Analysis: (15 Hours)

Analysis of various types of poisons: Corrosive, irritant, analgesic, hypnotic, tranquilizer, narcotic, stimulants, paralytic, antihistamine, domestic and industrial (gaseous and volatile)-food poisoning.

Unit – IV Physical and Chemical Methods of Forensic Analysis: (15 Hours)

Physical, Biological, and Chemical Methods: Basic principles of Non-destructive testing probes including radiography, Xera-radiography, Surface penetrations method (SEM and Laser Probes), Fluoroscopy, Immunological methods, DNA-finger printing, Examination and grouping of blood strains and seminal strains.

Unit – V Instrumental Methods of Forensic Analysis: (15 Hours)

Sample preparation, Calibration of the instruments for the accuracy and reproducibility of results in forensic analysis, Method validation technique and requirements, Procurement of standard samples, Forensic application of TLC, HPTLC, GC, HPLC, LC-MS, FT-IR, AAS, GC-MS, and UV-visible spectrophotometer.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. Kuby, "Immunology" by Richard A. Goldsby, Thomas J. Kindt, Barbara A.Osborne.

2. W.J. Welcher (Ed.), Scott's Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th edition (1975), Van Nostrand Reinhold Co. London.

Reference Books:

1. T. G. Cooper, The Tools of Biochemistry, John Wiley & Sons, 1977.

2. D.M. Kemeny (Editor), S.G. Challacombe (Editor), ELISA and other solid phase immunoassays – theoretical and practical aspects, Jossey-Bass, Jan. 1989.

3. Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London.

4. W. Horwitz, Official Methods of Analysis, 11th edition (1970), Association of Official Analytical Chemists, Washington DC.

5. K. Simpson and B. Knight, Forensic Medicine, 9th edition (1985), Edward Arnold Publishers Ltd., London.

e-Resources:

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	-	2	-	-	3	3	2	3
CO2	3	2	3	-	3	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	3	3	3
CO4	2	3	3	-	2	-	-	2	2	3	3
CO5	3	2	3	-	2	-	-	2	3	3	2
	2.8	**2.6**	**2.8**	**-**	**2.4**	**-**	**-**	**2.6**	**2.8**	**2.8**	**2.8**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. A. MUJTHABA AATIF	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*DSEC*	***P24ECH203***	***BIOINORGANIC CHEMISTRY (ELECTIVE - IV)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To understand the role of trace elements in biological systems.
- To understand the biological significance of metals. To study the toxicity of metals in medicines.
- To have knowledge of diagnostic agents and treatment methods using metal complexes.
- To discuss various metalloenzymes properties.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Analyze the role of trace elements in biological systems	**K4**
CO2	Understand and explain the biological redox systems.	**K2**
CO3	Illustrate the metal toxicity in living organisms.	**K3**
CO4	Evaluate the methods of diagnosis and treatment using bioinorganic chemistry	**K5**
CO5	Learn about the nitrogen fixation and photosynthetic mechanisms.	**K1**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Essential trace elements: (15 Hours)

Selective transport and storage of metal ions: Ferritin, Transferrin, and siderophores; Sodium and potassium transport, Calcium signaling proteins. Metalloenzymes: Zinc enzymes–carboxypeptidase and carbonic anhydrase. Iron enzymes–catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B_{12} coenzymes.

Unit – II Transport Proteins: (15 Hours)

Oxygen carriers -Hemoglobin and myoglobin - Structure and oxygenation, Bohr Effect. Binding of CO, NO, CN^- to Myoglobin and Hemoglobin. Biological redox systems: Cytochromes-Classification, cytochrome a, b, and c. Cytochrome P-450. Non-heme oxygen carriers- Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.

Unit – III Nitrogen fixation: (15 Hours)

Introduction, types of nitrogen-fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem-II-chlorophylls structure and function.

Unit – IV Metals in medicine: (15 Hours)

Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum containing anticancer agents- Chelation therapy - Cancer treatment. Diagnostic Agents: Technetium Imaging Agents, Gadolinium MRI Imaging Agents - temperature and critical magnetic Field.

Unit – V Enzymes: **(15 Hours)**

Introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation, and the effects of catalysis. Michaelis - Menten equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzymes.

Text Books:

1. Ajai Kumar, Organometallic and Bioinorganic Chemistry, 4th edition, Aaryush Education Publishers, New Delhi, India, 2021.

2. G.N. Mugherjea and Arabinda Das, Elements of Bioinorganic Chemistry, 4th edition, UN Dhur & Sons Pvt Ltd, 2012.

3. P.S. Kalsi, J. P. Kalsi, Bioorganic, Bioinorganic and Supramolecular Chemistry, 2nd edition, New Academic Science Publishers, India, 2011.

4. R. Gopalan, V. Ramalingam, Concise Coordination Chemistry, S. Chand Publishers, India, 2008.

Reference Books:

1. M. Satake and Y. Mido, Bioinorganic Chemistry, Discovery Publishing House, New Delhi, India, 2003.

2. R. M. Roat-Malone, Bio Inorganic Chemistry, 3rd edition, John Wiley, 2020.

3. Atkins, Overton, Rourke, Weller, Armstrong and Hagerman, Shriver & Atkins' Inorganic Chemistry; 5th edition, Oxford University Press, London, 2010.

4. Catherine E. Housecraft and Alan G. Sharpe, Inorganic Chemistry, 3rd edition, Pearson Publishers, UK, 2008.

e-Resources:

1. https://www.pdfdrive.com/instant-notes-in-inorganic-chemistry- the-instant-notes-chemistry-series-d162097454.html
2. https://www.pdfdrive.com/shriver-and-atkins-inorganic-chemistry- 5th-edition-d161563417.html
3. https://archive.nptel.ac.in/courses/104/104/104104109/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	3	3	3	3
CO2	2	3	3	-	3	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	3	3	3
CO4	3	2	3	-	2	-	-	3	3	3	3
CO5	2	3	3	-	3	-	-	3	3	3	3
	2.6	**2.8**	**3**	**-**	**2.8**	**-**	**-**	**3**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. A. AHMED RAZA	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*DSEC*	***P24ECH204***	***MATERIAL SCIENCE (ELECTIVE - IV)***	***75***	***3***	***25***	***75***	***100***

Objectives:

- To understand the crystal structure, growth methods and X-ray scattering.
- To explain the optical, dielectric and diffusion properties of crystals.
- To recognize the basis of semiconductors, superconductivity materials and magnets.
- To study the synthesis, classification and applications of nanomaterials.
- To learn about the importance of materials used for renewable energy conversion.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Understand and recall the synthesis and characteristics of crystal structures, semiconductors, magnets, nanomaterials and renewable energy materials.	**K2**
CO2	Integrate and assess the structure of different materials and their properties.	**K3**
CO3	Analyze and identify new materials for energy applications.	**K4**
CO4	Explain the importance of crystal structures, piezoelectric and pyroelectric materials, nanomaterials, hard and soft magnets, superconductors, solar cells, electrodes, LED uses, structures and synthesis.	**K2**
CO5	Design and develop new materials with improved property for energy applications.	**K6**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Crystallography: (15 Hours)

symmetry - unit cell and Miller indices - crystal systems - Bravais lattices - point groups and space groups - X- ray diffraction-Laue equations-Bragg's law-reciprocal lattice and its application to geometrical crystallography. Crystal structure–powder and single crystal applications. Electron charge density maps, neutron diffraction-method, and applications.

Unit – II Crystal growth methods: (15 Hours)

Nucleation–equilibrium stability and metastable state. Single crystal –Low and high temperature, solution growth– Gel and sol-gel. Crystal growth methods- nucleation– equilibrium stability and metastable state. Single crystal–Low and high temperature, solution growth– Gel and sol-gel. Melt growth - Bridgeman-Stockbarger, Czochralski methods. Flux technique, physical and chemical vapour transport. Lorentz and polarization factor - primary and secondary extinctions.

Unit – III Properties of crystals: (15 Hours)

Optical studies - Electromagnetic spectrum (qualitative) refractive index – reflectance – transparency, translucency and opacity. Types of luminescence – photo-, electro-, and injection luminescence, LEDs – organic, Inorganic and polymer LED materials - Applications. Dielectric studies- Polarisation - electronic, ionic, orientation, and space charge polarisation. Effect of temperature. dielectric constant, dielectric loss. Types of dielectric breakdown–intrinsic, thermal, discharge, electrochemical, and defect breakdown.

Unit – IV Special Materials: **(15 Hours)**

Superconductivity: Meissner effect, Critical temperature, and critical magnetic Field, Type I and II superconductors, BCS theory-Cooper pair, Applications. Soft and hard magnets – Domain theory Hysteresis Loop-Applications. Magneto and gian magneto resistance. Ferro, ferri and antiferromagnetic materials- applications, magnetic parameters for recording applications. Ferro-, Piezo-, and pyroelectric materials – properties and applications. Shape memory Alloys-characteristics and applications, Non-linear optics- Second Harmonic Generators, mixing of Laser wavelengths by quartz, ruby and LiNbO3.

Unit – V Materials for Renewable Energy Conversion: **(15 Hours)**

Solar Cells: Organic, bilayer, bulk heterojunction, polymer, perovskite-based. Solar energy conversion: lamellar solids and thin films, dye-sensitized photo voltaic cells, coordination compounds anchored onto semiconductor surfaces - Ru(II) and Os(II) polypyridyl complexes. Photochemical activation and splitting of water, CO_2, and N_2. Manganese-based photosystems for water-splitting. Complexes of Rh, Ru, Pd, and Pt - photochemical generation of hydrogen from alcohol.

Text Books:

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

2. Arumugam, Materials Science, Anuradha Publications, 2007.

3. Giacavazzo et. al., Fundamentals of Crystallography, International Union of Crystallography, Oxford Science Publications, 2010

4. Woolfson, An Introduction to Crystallography, Cambridge University Press, 2012.

5. James F. Shackelford and Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers. 6th edition, PEARSON Press, 2007.

Reference Books:

1. Suggested Readings 1. M.G. Arora, Solid State Chemistry, Anmol Publications, New Delhi, 2001.

2. R. K. Puri and V. K. Babbar, Solid State Physics, S Chand and Company Ltd, 2001.

3. C. Kittel, Solid State Physics, John-Wiley and sons, NY, 1966.

4. A.R. West, Solid State Chemistry and Applications, John-Wiley and sons, 1987.

e-Resources:

1. http://www.uptti.ac.in/classroom-content/data/unit%20cell.pdf.
2. https://bit.ly/3QyVg2R
3. http://xrayweb.chem.ou.edu/notes/symmetry.html.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	-	3	3	3	3
CO2	2	3	3	-	3	-	-	3	3	3	3
CO3	3	3	3	-	3	-	-	3	3	3	3
CO4	3	2	3	-	2	-	-	3	3	3	3
CO5	2	3	3	-	3	-	-	3	3	3	3
	2.6	**2.8**	**3**	**-**	**2.8**	**-**	**-**	**3**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

Prepared by	Verified by
Dr. Z. ANSAR ALI	Dr. S. ZAHEER AHMED

Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*SEC*	***P24SCH201***	***COMPUTATIONAL CHEMISTRY (SBS - I)***	***30***	***2***	***25***	***75***	***100***

Objectives:

- To provide an essential theoretical background in computational chemistry and practical and programming skills to perform scientific computations to solve chemical problems.
- To expose the students to a variety of computational tools in chemical science esp those related to Research.
- To impart knowledge on the principles and applications of various levels of drug design and development.
- To understand and perform computational skills for understanding the mechanism, interaction forces in drug actions, and quantitative measurement of biological responses.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Explain the concept of computers - hardware, software and internet.	**K2**
CO2	Obtain hands-on training in the context of currently available computational chemistry software and high-performance computer hardware.	**K3**
CO3	Identify the screening methods in the design of drugs	**K3**
CO4	Evaluate a theoretical understanding of how the computational chemistry reactions take place.	**K5**
CO5	Predict the functional groups involved in drug action and modifications required for a better biological response.	**K5**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Basics of Computers: (6 Hours)

Hardware and Software definitions – Types of Languages: Higher level and lower languages, examples. BIOS and RAM: Significance. – Central Processing Unit and GPU Input Devices. Basics of the Internet: DNS, ISP, DSL, https, www, URL, LAN and WAN, Repeater / Modem. Cloud computing and supercomputers – Definitions, Examples.

Unit – II Fundamentals of Computational Chemistry and Software: (6 Hours)

Molecular Dynamics, Semi-empirical methods, Ab-initio, Molecular Mechanics and Density Functional Theory – Definitions and Significance. Introduction to Software available for all the above methods (Opensource like AMBER, MOPAC, GAMESS) including web-based (online submission). Format conversions: OpenBabel.

Unit – III Geometry optimization: (6 Hours)

Input generation using coordinates and z matrix. Generation of coordinates for Water, Hydrogen Peroxide, Formaldehyde, Methane, Ethane, Ethylene, Benzene, and Aniline. Calculation of properties from these methods, including zero-point energy and reaction coordinates (description).

Unit – IV Cheminformatics and Molecular Modelling: (6 Hours)

Molecular descriptors to include HOMO, LUMO, Softness, Hardness, Dipole moment, Surface area, and log P. Fukui functions for predicting the reactivity of molecules using FMO - Nucleophilicity and Electrophilicity - Use of Hammett-Taft equation.

Unit – V Drug Designing Basics: **(6 Hours)**

Drug Designing basics to include action mechanisms and using PDB structures for docking with software and Score prediction. Ramachandran Plot. Protein Data Base and its significance. Practical Aspects of Structure-Based Virtual Screening Prediction of ADMET Properties – Lipinski Rule.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. An Introduction to Chemoinformatics, Revised Edition, Andrew R. Leach and Valerie J. Gillet, Springer Publisher. 2007.

2. Richard B. Silverman, The organic chemistry of drug design and drug action: third edition, Elsevier Publishers, 2014.

3. Hugo Kubinyi, QSAR: Hansch Analysis and Related Approaches, Vol.1, VCH Publishers, 2006.

4. F. Jensen, Introduction to Computational Chemistry, 3rd edition, John Wiley & Sons Ltd, UK, 2017.

5. Molecular Modelling Basics, Jan H. Jensen, CRC Press, Taylor & Francis Group, 2010.

6. Bio-informatics, S. C. Rastogi, N. Mendiratta and P. Rastogi, Prentice Hall India.

Reference Books:

1. Kenneth M. Merz, Jr, Dagmar Ringe, Charles H. Reynolds, Drug Design: Structure- and Ligand-Based Approaches, Cambridge University Press, 2010.

2. Tommy Liljefors, Povl Krogsgaard-Larsen, Ulf Madsen, Textbook of Drug Design and Discovery, Third Edition, CRC Press, 2006.

3. Essentials of Computational Chemistry, Theories and Models, Second Edition, Christopher J. Cramer, John Wiley & Sons Ltd, 2004.

4. Molecular Modelling – Principles and Applications, Andrew R. Leach, Pearson Education Ltd.

e-Resources:

1. https://ocw.mit.edu/courses/5-04-principles-of-inorganic-chemistry-ii-fall-2008/pages/syllabus/
2. https://nptel.ac.in/
3. https://swayam.gov.in

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	-	-	3	3	3	3
CO2	3	3	2	3	2	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	3	2	3	3
CO4	3	3	3	3	3	-	-	3	3	3	3
CO5	3	3	3	3	2	-	-	3	3	3	3
	3	**2.8**	**2.6**	**3**	**2.4**	**-**	**-**	**3**	**2.8**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

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Sem	*Category*	*Course Code*	*Course Title*	*Hours*	*Credits*	*Int. Marks*	*Ext. Marks*	*Max. Marks*
II	*AEC*	***P24CRM201***	***RESEARCH METHODOLOGY***	***30***	***2***	***25***	***75***	***100***

Objectives:

- To introduce the purpose and importance of research for future development.
- To know the various steps in the Research Literature Survey.
- To learn how to identify research problems.
- To develop the skills of students for seminar and paper presentations.

Course Outcomes (COs) and Cognitive Level Mapping:

COs	CO Statement (On the successful completion of the course, the students will be able to)	Cognitive Level
CO1	Explain the concept of research and different types of research.	**K2**
CO2	Survey the literature in the selected field of research.	**K3**
CO3	Analyze the Research Problems in the selected field.	**K4**
CO4	Evaluate and Identify appropriate Research Problems.	**K5**
CO5	Develop report writing-related skills.	**K6**

Cognitive Levels (K1-Remember**; K2-**Understand**; K3-**Apply**; K4-**Analyze**; K5-**Evaluate**; K6-**Create**)**

Syllabus:

Unit–I Fundamentals of Research: (5 Hours)

Definition and Purpose of Research - Objectives of Scientific Research - Types of research: Basic research - Applied research, and Multidisciplinary Research.

Unit – II Research Literature Survey: (5 Hours)

Introduction to the literature-non-patent primary literature: Journals - communications, articles, reviews, conference papers, reports, abstracts, and preprints- patents. Secondary literature: Books. Web resources, E-journals, Journal access, TOC alerts, Hot articles, E-consortium, UGC Infonet, E-books, Preprint servers, Literature search tools - SCOPUS, Google Scholar, PUBMED, Web of Science, Indian Citation Index.

Unit – III Technical Writings: (8 Hours)

Technical communications: Technical and non-technical, outlines; documents: Full-length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Project proposal Components of research paper: Title/Topic statement, Abstract/ keywords.

Components of thesis: aim and objectives, hypothesis building, rationale of the paper, work plan, materials and methodology, results and discussion, key issues and arguments, acknowledgment, conflict of interest statement, bibliography, technical resumes, and cover letters

Components of a research proposal: project summary, keywords, origin of the proposal, major objectives, methodology, overview of status of research and development in the subject, importance of the proposed project in the context of current status, bibliography/references. Styles of referencing - APA, MLA, Oxford, Harvard, Chicago Annotated bibliography. Tools for citing and referencing - Grammarly, Mendeley.

Unit – IV Formulation of Research Problem: (7 Hours)

Identification of research problem – literature survey on selected problem - preliminary analysis carried out - methodology adopted - research work executed.

Unit – V Presentation and Communication skills: **(5 Hours)**

Tables, figures, graphs, and diagrams – ChemDraw, MS Excel, and PowerPoint slides. Poster preparation. Writing ethics- Avoid plagiarism, communication skills, oral and poster presentations.

 # _____# Self Study Component for Seminar/Assignment:
(Questions should not be asked from self study component in the End Semester Examinations)

Text Books:

1. Kothari, C. Research Methodology Methods & Techniques – New Age International Publishers, Reprint 2008.

2. Anderson, J. Thesis and Assignment Writing, Wiley Eastern Ltd., 1997.

3. Mukul Gupta, Deepa Gupta, Research Methodology – PHI Learning Private Ltd., New Delhi, 2011.

4. Rajammal, P. Devadoss and K. Kulandaivel, A Hand Book of Methodology of Research, RMM Vidyalaya press, 1976.

Reference Books:

1. Dominoswki, R L, Research Methods, Prentice Hall, 1981.

2. Ebel, H F, Bliefert, C and Russey, W E, The Art of Scientific Writing, VCH, Weinheim, 1988.

3. Dawson, C, Introduction to Research Methods: A practical guide for anyone undertaking a research project 5th edition, Robinson, 2019.

e-Resources:

1. https://paperpal.com/blog/academic-writing-guides/what-is-research-methodology
2. https://www.indeed.com/career-advice/career-development/research-methodology
3. https://library.tiffin.edu/researchmethodologies/whatareresearchmethodologies

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	-	-	3	3	3	3
CO2	3	3	3	3	1	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	3	3	3	3
	3	**3**	**3**	**2.6**	**2.2**	**-**	**-**	**3**	**3**	**3**	**3**

3 – Strong; 2 – Medium; 1 – Low

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