

SEMESTER-II

ANALYTICAL CHEMISTRY-II

1. Course Description

Programme: M.Sc. Organic Chemistry
Course Code: P24/CHE/DSC/204
Course Type: DSC-4
No. of credits: 3

Max. Hours : 45
Hours per week: 3
Max. Marks: 100

2. Course Objectives

- To learn Basic and Advanced Electro-analytical techniques
- To understand basics and applications of ^1H , ^{19}F and ^{31}P NMR in organic compounds
- To apply techniques of Mass Spectroscopy to determine fragmentation, and molecular weight, and learn advanced mass spectroscopic techniques like FAB, SIMS, MALDI etc.

3. Course Outcomes

CO1: Explain the principle and applications of Polarography, Cyclic Voltammetry, differential thermal analysis, and Differential scanning calorimetry.
(UNDERSTANDING)

CO2: Discuss the principles, chemical shifts, coupling constants, and application of ^1H , ^{19}F , ^{31}P and solid-state NMR spectroscopy. (APPLICATION)

CO3: Outline salient features of fragmentation pattern of organic compounds using the Principles and instrumentation of different types of mass spectrometers
(UNDERSTANDING)

4. Course Content

MODULE 1: ELECTRO AND THERMAL ANALYTICAL TECHNIQUES: (15Hrs)

I: Types and Classification of Electro analytical Methods:

a) D.C Polarography: Instrumentation - Dropping mercury electrode- -polarogram. Types of Currents: Residual, Migration, Limiting. Two and Three electrode assemblies Ilkovic equation (derivation not necessary) and its consequences Applications of polarography in qualitative and quantitative analysis. Analysis of mixtures. Application to inorganic and organic compounds. Determination of stability constants of complexes.

b) Brief account of following techniques and their advantages over conventional D.C.Polarography

(i) A.C.polarography (ii) Square-wave polarography (iii) Pulse polarography (iv) Differential pulse polarography

c) Amperometric titrations: Principle, Instrumentation. Types and applications of amperometric titrations. Determination of SO_4^{2-} , metal ions viz., Mg^{2+} , Zn^{2+} , Cu^{2+} and other substances.

d) Cyclic Voltammetry: Principle, instrumentation, Applications. Cyclic voltametric study of insecticide parathion.

II: Thermal Analysis: Thermal Techniques-Introduction, types of thermal-analytical methods. Thermogravimetry principle and applications of thermogravimetry differential thermal analysis-principle and applications of DTA Differential scanning calorimetry DSC: Principle, and application of DSC.

MODULE 2: NMR-II and ESR SPECTROSCOPY (15 Hrs)

Multinuclear NMR (^1H , ^{19}F AND ^{31}P NMR) and solid-state NMR spectroscopy:

First order and non-first order spectra e.g., AX, AX₂, AX₃, A₂X₃, AMX and AB, ABC. Simplification of complex spectra: increased field strength, deuterium exchange, Lanthanide shift reagents and double resonance techniques. Discrimination of enantiomers by use of chiral NMR solvents (CSAs), chiral lanthanide shift reagents and Mosher's acid. Nuclear Overhauser enhancement (NOE). Fluxional molecules bullvalene, $[\eta^1\text{-C}_5\text{H}_5\text{M}]$, $[\eta^5\text{-(C}_5\text{H}_5)_2\text{Ti}\eta^1\text{-(C}_5\text{H}_5)_2]$ and $[\eta^4\text{C}_8\text{H}_8\text{Ru(CO)}_3]$.

^{19}F NMR spectroscopy: ^{19}F chemical shifts, coupling constants. Applications of ^{19}F NMR involving coupling with ^{19}F , ^1H and ^{31}P : 1,2-dichloro-1,1-difluoroethane, BrF_5 , SF_4 , PF_5 , ClF_3 , IF_5 , $\text{CF}_3\text{CH}_2\text{OH}$.

^{31}P NMR spectroscopy: ^{31}P chemical shifts, coupling constants. Application of ^{31}P NMR involving coupling with ^{31}P , ^{19}F , ^1H and ^{13}C : ATP, Ph_3PSe , P_4S_3 , H_3PO_4 , H_3PO_3 , H_3PO_2 , HPF_2 , PF_6^- , PH_3 , $[\text{Rh}(\text{PPh}_3)\text{Cl}]$ ($\text{Rh I}=1/2$)

Introduction to solid-state NMR: Magic Angle Spinning (MAS). Applications of solid-state NMR.

Electron Spin Resonance Spectroscopy: Introduction, principle, instrumentation, selection rules, calculation of 'g'. Study of free radicals.

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MODULE 3: MASS SPECTROMETRY:**(15 Hrs)**

Origin of mass spectrum, principle of EI mass spectrometer. Types of fragments: odd electron and even electron containing neutral and charged species (even electron rule), Nitrogen rule, isotopic peaks, determination of molecular formula, metastable ion peaks. High resolution mass spectrometry Salient features of fragmentation pattern of organic compounds including β -cleavage, McLafferty rearrangement, retro Diels – Alder fragmentation and ortho effect.

Principle of EI, CI, Atmospheric Pressure Ionisation (API), Secondary Ion Mass Spectrometry (SIMS), Electrospray ionization (ESI) and Matrix Assisted Laser Desorption Ionization (MALDI) methods.

Introduction, principle, and applications of Gas Chromatography-Mass Spectrometry (GC-MS) and Liquid chromatography-Mass Spectrometry (LC-MS) techniques.

5. References

1. Principles of Polarography, Heyrovsky, Elsevier Inc.
2. Principles of Polarography, Kapoor, John Wiley & Sons.
3. Modern Electroanalytical methods, edited by C.Charlot. Elsevier Company.
4. Principles of Instrumental analysis, Skoog, Holler and Nieman, Harcourt Asia PTE Ltd.
- 5 Analytical Chemistry-An Introduction, Skoog, West, Holler and Crouch, Saunders College Publishing
- 6 Principles of Instrumental Analysis, Skoog and Leary, Saunders College Publishing.
- 7 Spectroscopic identifications of organic compounds by R.M. Silverstein and F.X. Webster. John Wiley & Sons
8. Instrumental Methods of Chemical Analysis by BK Sharma, Krishna Prakashan Pvt. Ltd.
9. Instrumental Methods of Analysis by Willard, New York, Van Nostrand
10. Organic spectroscopy by William Kemp, Palgrave Macmillan.
11. NMR-A multinuclear introduction by William Kemp, Springer
12. Spectroscopic methods in organic chemistry by D.H. Williams and I. Fleming McGraw-Hill Education


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1. Syllabus Focus

a) Relevance to Local, Regional, National and Global Development Needs

Local/Regional/National /Global Development Needs	Relevance
LOCAL	Quality control in manufacturing processes, medical diagnostics, safeguarding local ecosystems
REGIONAL	Regional advancements in material sciences, drug discovery and development, ensuring the efficacy of pharmaceutical products
NATIONAL	National security for the analysis of materials, for studying materials used in energy storage, and efficiency improvement
GLOBAL	Global pharmaceutical research contributing to drug development, assessing environmental impact of industrial activities, and forensic investigations

b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
SD	Module No. 1	Present real-world industry problems related to analytical techniques, and discuss the solutions with students
ED	Module No.2	Invite successful entrepreneurs in the field to share their experiences, challenges and insights
EMP	Module No. 3	Helping students gain practical experience and exposure to real-world applications

2. Pedagogy

S. No	Student Centric Methods Adopted	Type/ Description of Activity
1.	Problem Solving	Case studies
2.	Experiential Learning	Field Trips
3.	Participative Learning	Presentation

3. Course Assessment Plan

a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments CIA-40%	End Semester Examination-60%
CO1	CIA-1 - Written Exam	Written Exam
CO2	CIA-2 - Presentation	
CO3	CIA-2 - Assignment	

SECTION A - INTERNAL CHOICE			3 Q X 12 M = 36 M	
Question Number	Module	Question	CO	BTL
1	Module 1	(a) Explain the principle of cyclic voltammetry and describe the cyclic- Voltammogram of insecticide parathion (b) Write the principle and application of DTA.	CO 1	(Level-II) (Level-I)
2	Module 1	(a) Explain The Principle of TGA With Examples And its applications. (b) Write a short note on Pulse Polarography and Square Wave Polarography	CO 1	(Level-II) (Level-I)
3	Module 2	(a) Predict The ^1H NMR Spectra of AMX and ABC type. (b) What Is NOE? Discuss any two of its applications.	CO 2	(Level-II) (Level-I)
4	Module 2	(a) Explain the simplification of NMR spectra by any two instrumental techniques. (b) Discuss applications ^{19}F NMR.	CO 2	(Level-II) (Level-II)
5	Module 3	(a) Explain Mclafferty rearrangement using a suitable example (b) Write notes on the mass fragmentation pattern of carbonyl compounds.	CO 3	(Level-II) (Level-I)
6	Module 3	(a) Write the principle and applications involved in GC-MS (b) What is the ortho effect and how is it useful in mass spectrometry?	CO 3	(Level I) (Level I)
SECTION B - ANSWER ANY 4 OUT OF 6 (To compulsorily have Two questions from each module)			4Q X 6 M = 24 M	
7	Module 1	What is the role of DME in polarography explain with diagram.	CO 1	(Level-II)
8	Module 1	Explain different types of Amperometric titration with suitable examples.	CO 1	(Level-II)
9	Module 2	What is Magic angle spinning Explain its importance?	CO 2	(Level-I)
10	Module 2	Explain the principle and instrumentation of ESR Spectroscopy.	CO 2	(Level II)
11	Module 3	Discuss the Retro-Diels-Alder fragmentation pattern with examples.	CO 3	(Level-II)
12	Module 3	Write about ESI and MALDI	CO 3	(Level-I)

b) Model Question Paper- End Semester Exam**ANALYTICAL CHEMISTRY-II
MODEL QUESTION PAPER
THEORY****Course Code: P24/CHE/DSC/204****Max Marks:60****Credits: 3****Max Hours:2½hrs****SECTION-A****I Answer the following questions****3X12=36 Marks**

1. a) Explain the principle of cyclic voltammetry and describe the cyclic- Voltammogram of insecticide parathion (CO1) (Level II)
b) Write the principle and application of DTA. (CO1) (Level I)

OR

2. a) Explain The Principle of TGA With Examples And its applications. (CO1) (Level II)
b) Write a short note on Pulse Polarography and Square Wave Polarography (CO1) (Level I)
3. a) Predict The ^1H NMR Spectra of AMX and ABC type. (CO2) (Level II)
b) What Is NOE? Discuss any two of its applications. (CO2) (Level I)

OR

4. (a) Explain the simplification of NMR spectra by any two instrumental techniques with one example each. (CO2) (Level II)
b) Discuss applications ^{19}F NMR. (CO2) (Level II)

5. a) Explain McLafferty rearrangement using a suitable example (CO3) (Level II)
b) Write notes on the mass fragmentation pattern of carbonyl compounds.
(CO3) (Level I)

OR

6. a) Write the principle and applications involved in GC –MS (CO3) (Level I)
b) What is the ortho effect and how is it useful in mass spectrometry? (CO3)
(Level I)

SECTION-B

II Answer any four questions

4 X 6 = 24 M

7. What is the role of DME in polarography explain with diagram. (CO1) (Level II)
8. Explain different types of Amperometric titration with suitable examples. (CO1) (Level II)
9. What is Magic angle spinning Explain its importance? (CO2) (Level I)
10. Explain the principle and instrumentation of ESR Spectroscopy. (CO2) (Level II)
11. Discuss the Retro-Diels-Alder fragmentation pattern with examples. (CO3) (Level II)
12. Write about ESI and MALDI (CO3) (Level I)

a. Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	1	2	12	2	4 × 6 = 24
2	15	2	2	12	2	
3	15	3	2	12	2	

CO-PO Mapping

CO	PO	Cognitive Level	Classroom sessions (hrs)
1	1	Understanding	15
2	5	Evaluating	15
3	2	Problem solving	15

SEMESTER-II PRACTICALS

CHEMISTRY LAB: DSC- 4

LAB: ANALYTICAL CHEMISTRY

Program: M.Sc.
Course: DSC-4
Semester: II

Subject Code P24/CHE/DSC/204/P
No. of Hrs. allotted: 4 Hrs / week
No. of Credits : 2

COURSE OBJECTIVES:

- To estimate quantities using various titration techniques
- To interpret various organic compounds using spectral analysis

- To give the composition of substances through instrumental analysis

COURSE OUTCOMES:

This course will help the students to

CO1: Determine the unknown concentration of a substance by titration.

CO2: Elucidate the characterization of a compound's elemental composition.

CO3: Generate accurate data and determine the quantity of components.

Lab course 4

Analytical Chemistry

4 hrs/week

I. Applied analysis:

1. Estimation of alkali content in antacid by acid base titration method

2. Estimation of ascorbic acid in vitamin C by iodometry

3. Estimation of available oxygen in hydrogen peroxide by permanganometry

4. Estimation of calcium in milk by complexometry

5. Determination of hardness of water by complexometry.

II. Spectral analysis: Interpretation of IR, UV, ¹H NMR and MS of the following representative compounds

6. An aldehyde

7. An alcohol

8. A carboxylic acid

9. An amine

10. A Ketone

III. Instrumental Analysis:**Conductometry:**

11. Titration of a mixture of strong and weak acids vs weak base

Potentiometry:

12. Titration of Fe^{+2} vs $\text{Cr}_2\text{O}_7^{-2}$ (redox titration)

13. Fe^{+2} vs Ce^{+4} and calculation of formal redox potential of Fe(II)/Fe(III)

14. Fe^{+2} vs MnO_4^- and calculation of formal redox potential of Fe(II)/Fe(III)

pH metry:

15. Titration of a mixture of strong and weak acids vs strong base

References:

1. Vogel's textbook of Quantitative Inorganic Analysis, 6 edition, J. Mendham et al, Pearson education 11d (2002)
2. Advanced practical chemistry, R. Mukhopadhyay & P. Chatterjee, NCRA books (2016)
3. Advanced practical inorganic chemistry, Gurdeep Raj, GOEL publishing house (2015)
4. Advanced experimental Inorganic chemistry. Ayodhya Singh, Campus Books International (2006)
5. Senior Practical Physical Chemistry: BD Khosia, VC. Garg and A. Khosla
6. Advanced Practical Physical Chemistry J.B. Yadav
7. Organic structures from spectra. L. D. Field, S. Sternhell, J. R. Kaiman

**ANALYTICAL CHEMISTRY
PRACTICAL MODEL PAPER**

Course Code: P24/CHE/DSC/204/P

Credits: 2

Max Time:3hrs




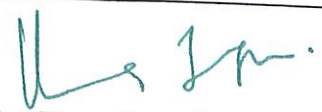
Max marks :50 marks

Answer all questions.

1. Write the Principle involved in the given experiment. **(CO1, CO2, CO3) 5 M**
2. a) Determine the strength of the given substance using Conductometer/Potentiometer/pH-meter. **(CO3)**

OR

- b) Estimate the amount of the substance using iodometry/ permanganometry/ complexometry/ acid base titration. **(CO1). 20M**
3. Interpret the given spectral data (IR, UV, ¹H -NMR, Mass) of the given compound and deduce the structures by following a systematic procedure. **(CO2) 10M**
4. Record and Attendance **5 M**
5. Viva Voce **(CO1, CO2, & CO3) 10 M**

Prepared by	Checked & verified by	Approved by
Name and Signature of the teaching faculty	Name and Signature of HoD	Name and Signature of Principal
 Dr. Sabiha Fatima  Dr. B. Uma Rani	 Dr. Sumalatha  Dr. Uma Joseph	

SEMESTER-II

INORGANIC CHEMISTRY -II

1. Course Description

Programme: M.Sc Chemistry
 Course Code: P24/CHE/DSC/201
 Course Type: DSC -5
 No. of credits: 3

Max.Hours: 60
 Hours per week: 3
 Max. Marks:60

2. Course Objectives

- To study and understand the current classification of Inorganic Reaction Mechanisms.
- Working at the atomic and molecular level, with help of terms and symbols to identify a Physical method of structural investigation of metal complex i.e. Electron absorption Spectra.
- To provide a good understanding of metal cluster compounds with respect to their synthesis, structure and properties. Boranes, Carboranes their synthesis and various bonding aspects will be focused.

3. Course Outcomes

CO1: Discuss how ligand substitution reaction takes place in octahedral and square Planar, trans effect and trans influence and how trans effect is applicable in synthesis of different metal complexes

CO2: Discuss terms, state, microstate, Orgel diagram and calculate microstates & Terms of different configurations with reference to interelectronic repulsions and Spin Orbital Perturbations

CO3: Discuss classification of clusters and different structural patterns of metal clusters. Explain how low nuclearity clusters differ from high nuclearity clusters and capping rule in metal clusters. Application of Wade's Rules in classification of metal Clusters, Boranes and Carboranes

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$[\text{Nb}_6(\text{Cl})_{12}]^{2+}$. Trinuclear halides of Re(III). Hoffman's Isolobal analogy and its Structural implications.

Boranes, Carboranes, STYX Rule. Stereochemical non-rigidity in $[\text{Rh}_4(\text{CO})_{12}]$ and $[\text{Fe}_2(\text{Cp})_2(\text{CO})_4]$.

5. References

1. Inorganic Reaction Mechanisms. M.L. Tobe and John Burgess, Addison Wesley Longman (1999).
2. Metal ions in Reaction Mechanisms. K. Veera Reddy. Golgotia Publications (P) Ltd
3. Mechanisms of Reactions in Transition Metal Sites. Richard A Henderson, Oxford Science Publications, London (1993).
4. Inorganic Reaction Mechanisms, F. Basolo and R.G. Pearson, New York (1967).
5. Advanced Inorganic Chemistry. F.A. Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, 6th Edition, Wiley Interscience, N.Y (1999)
6. Inorganic Chemistry, J.E. Huheey, K.A. Keiter and R.L. Keiter 4th Edition Harper Collins College Publications (1993)
7. Inorganic Biochemistry Edited by G.L. Eichorn, Volume 1 Elsevier (1982).
8. The Chemistry of Metal Cluster Complexes. D.F. Shriver, H.D. Kaerz and R.D. Adams (Eds), VCH, NY (1990).
9. Inorganic Chemistry, Keith F. Purcell and John C. Kotz, Holt-Saunders International Editions, London (1977).
10. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and S.J. Valentine, Viva Low-Priced Student Edition, New Delhi (1998).
11. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, W. Kain and B. Schwederski, John Wiley and Sons, NY (1999).

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1. Syllabus Focus**a) Relevance to Local, Regional, National and Global Development Needs**

Local/Regional/National /Global Development Needs	Relevance
Global	The study has its goal to understand Reaction mechanism of Inorganic complexes by which new complexes can be synthesized
National	Term symbols for electronic configurations are useful not only to the spectroscopist but also to the inorganic chemist interested in understanding electronic and magnetic properties of molecules.
Global	Interdisciplinary applications in Research and Industry

b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
ED	Module 1	Based on Concepts of Reaction mechanism New metal complexes can be synthesized which act as drug molecules in Pharma Industry
ED	Module 2	Concepts of Terms , states and microstates generated from an electronic configuration provides job opportunities as spectroscopic Analyst
ED	Module 3	Metal Clusters widely used as Catalysts in Industry

2. Pedagogy


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S. No	Student Centric Methods Adopted	Type/ Description of Activity
1.	Experiential Learning	Interactive Classroom Quiz
2.	Problem solving	Spectral analysis
3.	Participative Learning	Seminar

3. Course Assessment Plan

a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments CIA-40%	EndSemesterExamination-60%
CO1	CIA-2	Models
CO2	CIA -1	Written Exam
CO3	CIA-2	Seminar /Google form

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SEMESTER –II
INORGANIC CHEMISTRY PAPER-II
MODEL THEORY QUESTION PAPER

Course Code: P24/CHE/DSC/201

Credits:-3


Max Marks:60

MaxHours:2½hrs

SECTION A - INTERNAL CHOICE					3 Q X 12 M = 36 M
Question Number	Module	Question	CO	BTL	
1	Module 1	(a) Explain Nucleophilic Substitution in Metal complexes (a) Draw the Energy Profile diagram of SN1 & SN2 Reaction mechanisms	CO 1	(Level-II) (Level-II)	
2	Module 1	a) Explain in detail about SN ¹ CB Base Hydrolysis reaction and evidences in favor of Base hydrolysis b. Explain the mechanism of outer sphere Electron Transfer reaction with example	CO 1	(Level-V) (Level-II)	
3	Module 2	a) Define Microstates and calculate the number of Microstates in d ² Configuration b) Explain the concept of Hole Formalism in with suitable examples	CO 2	Level-I Level-II	
4	Module 2	a) Write about inter-electronic repulsion and Spin-orbital coupling parameters. b) Draw an Orgel diagram for ² D energy term in Octahedral and Tetrahedral Environment.	CO 2	(Level-I) (Level-II)	


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5	Module 3	a) Write an account on Polyhedral Skeletal Electron pair theory and explain the Structural pattern in $[\text{Rh}_6(\text{CO})_{16}]$ b) Give the structural Pattern in $\text{M}_4(\text{CO})_{12}$ with $\text{M}=\text{Co}, \text{Rh}, \text{Ir}$	CO 3	(Level-II) (Level-I)
6	Module 3	a) Explain the Structure and Bonding in $[\text{Re}_2\text{Cl}_8]^{-2}$ b) Give an account on Metal Halide Clusters	CO 3	(Level V) (Level IV)
SECTION B - ANSWER ANY 4 OUT OF 6 (To compulsorily have Two questions from each module)			4Q X 6 M = 24 M	
7	Module 1	Write a Short Note on Trans Effect and its Applications. L-I	CO 1	(Level-II)
8	Module 1	Explain the Inner sphere mechanism with an example. L-II	CO 1	(Level-V)
9	Module 2	List Hund's rules to explain the energy ordering of terms with example. L-I	CO 2	(Level-IV)
10	Module 2	Draw the Orgel diagram for $4F$ Energy Term for Octahedral Geometry.	CO2	(Level-II)
11	Module 3	What is STYX Rule, explain with an example .	CO3	(Level-I)
12	Module 3	Explain Hoffman's Isolobal analogy with suitable examples L-II	CO3	(Level-II)

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INORGANIC CHEMISTRY PAPER-II
MODEL THEORY QUESTION PAPER

Course Code: P24/CHE/DSC/201

Credits:-3

Max Marks:60

MaxHours:2½hrs

SECTION-A

I Answer the following Questions

3x12= 36M

1 a) Write a short note on Nucleophilic Substitution in Metal complexes

b) Draw the Energy Profile diagram of SN^1 & SN^2 Reaction mechanisms
OR2 a) Explain in detail about SN^1 Base Hydrolysis reaction and evidences in favour of
Base hydrolysis

b. Explain the mechanism of outer sphere Electron Transfer reaction with example.

3 a) Define Microstates and calculate the number of Microstates in d^2 Configuration

b) Explain the concept of Hole Formalism in with suitable examples.

OR

4 a) Write about inter-electronic repulsion and Spin-orbital coupling parameters

b) Draw an Orgel diagram for 2D energy term in Octahedral and Tetrahedral Environment5 a) Write an account on Polyhedral Skeletal Electron pair theory and explain the Structural
pattern in $[Rh_6(CO)_6]^{3+}$ b) Give the structural Pattern in $M_4(CO)_4$ with $M=Co, Rh, Ir$

OR

6 a) Explain the Structure and Bonding in $[Re_2Cl_8]^{2-}$

b) Give an account on Metal Halide Clusters

SECTION -B**Answer any five questions****(4x6=24)**

7. Write a Short Note on Trans Effect and its Applications.
8. Explain the Inner sphere mechanism with an example.
9. List Hund's rules to explain the energy ordering of terms with example.
10. Draw the Orgel diagram for $4F$ Energy Term for Octahedral Geometry.
11. What is STYX Rule, explain with an example .
12. Explain Hoffman's Isolobal analogy with suitable examples

b) Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	1	2	12	2	4 × 6 = 24
2	15	2	2	12	2	
3	15	3	2	12	2	

4. CO-PO Mapping

CO	PO	Cognitive Level	Class room sessions (hrs)
1	2	Applying	15Hrs
2	3	Understanding	15Hrs
3	3	Understanding	15Hrs

SEMESTER-II PRACTICALS**CHEMISTRY LAB: DSC- 5****LAB: INORGANIC CHEMISTRY**

Program: M.Sc.

Subject Code P24/CHE/DSC/201/P

Course: DSC-5

No. of Hrs. allotted: 4 Hrs / week

Semester: II

No. of Credits : 2

COURSE OUTCOMES:

CO1: Separation and Estimation of metals by Ion Exchange Resin method & Synthesis of Metal complexes by simple procedures.

CO2: Understand the importance of Inorganic Qualitative and Quantitative Analysis and its use in Research and industry.

Inorganic Chemistry Lab course**I. Preparation of complexes:**

1. Mercury Tetra Thio cyanate Cobaltate(II).
2. Chloropentammine Cobalt(III) chloride
3. Tetrammine copper(II) sulphate

II. Titrimetric Analysis of two ions in a mixture

4. Estimation of Pb^{2+} and Ca^{2+}
5. Estimation of Zn^{2+} and Mg^{2+}
6. Estimation of Mg^{2+} and Mn^{2+}

III. Analysis of Two component mixtures

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7, 8. Separation of Ag^+ and Ca^{2+} in a mixture and Estimation of Ag^+ (Gravimetric) and Ca^{2+} (Volumetric).

9, 10. Separation of Cu^{2+} and Ni^{2+} in a mixture and Estimation of Ni^{2+} (Gravimetric) and Cu^{2+} (Volumetric)

11, 12. Separation of Fe^{3+} and Al^{3+} in a mixture and estimation Fe^{3+} (Volumetric) of Al^{3+} (gravimetric).

IV. Analysis of three component mixtures:

13. Separation of (Ni^{2+} and Cu^{2+}) from Mg^{2+} in the given mixture and estimate Mg^{2+} gravimetrically

V. Ion exchange methods of analysis:

14. Determination of capacity of an ion exchange resin.

15. Separation of Mg^{2+} and Zn^{2+} on an anion exchange resin and estimation of Zn^{2+} and Mg^{2+}

References

1. Text book of Quantitative Inorganic Analysis, 3rd edition, A.I. Vogel, ELBS (1969)
2. Vogel's text book of Quantitative Inorganic analysis, 4th edition, Jeffery et al, ELEBS (1988)
3. Vogel's text book of Quantitative Inorganic Analysis, 6th edition, J. Mendham Etal Pearson education ltd (2002).
4. Practical Inorganic chemistry, G.Marr and B.W.Rockett, Van Nostrand Reinhold
5. Experimental Inorganic/Physical Chemistry An Investigative integrated approach to Practical Project work, Mounir A.Malati, Woodhead publishing ltd (1999).
6. Advanced experimental Inorganic chemistry, Ayodhya Singh, Campus books international (2006)
7. Practical Inorganic Chemistry, G. Pass & H. Sutcliffe, University science books (1999)




**INORGANIC CHEMISTRY
PRACTICAL MODEL PAPER**

Course Code : P20/CHE/DSC/201/P
Credits: 2

Max Time:3hrs
Max marks :50 marks

Answer all questions

1. Explain the principle and procedure for the Synthesis of the metal complex (CO1) 10 M
OR
2. Explain the Principle of separation of Mg^{+2} and Zn^{+2} on an Anion Exchange Resin and estimation of Mg^{+2} and Zn^{+2} (CO1)
3. Separate the metal ions in the given mixture solution and estimate ----- Metal ion by Gravimetric method and ----- metal by Volumetric method . (CO2) (25M)
4. Record and Attendance (5M)
5. Viva Voce (10)

Prepared by	Checked & verified by	Approved by
Name and Signature of the teaching faculty	Name and Signature of HoD	Name and Signature of Principal
 Dr D. Sumalatha	 Dr D. Sumalatha	 Dr. Uma Joseph



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Osmania University, Hyderabad-07.



Head
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SEMESTER – II

ORGANIC CHEMISTRY-II

1. Course Description

Programme: M.Sc. Organic Chemistry

Course Code: P24/CHE/DSC/202

Course Type: DSC –6

No. of credits: 3

Max. Hours: 45

Hours per week: 3

Max. Marks: 60

2. Course Objectives

- To identify neighbouring group participation and to explain and calculate the reaction processes of various chemical reactions and involvement of different reaction intermediates in molecular rearrangements.
- To forecast the application of orbital correlation diagrams, FMO, and ATS selection rules on different pericyclic reactions
- To discuss different important photochemical reactions like Di-Pi methane rearrangement, Norrish type-I, Norrish II type reactions, Paterno Bucchi and Barton reaction.

3. Course Outcomes

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

CO1: Discuss the criteria for determining the participation of neighbouring groups in reaction mechanism, Generation, detection, structure, stability and reactions of carbenes and nitrenes and their involvement in various rearrangements (**Understanding**).

CO2: Outline the selection rules for different Pericyclic reactions by various methods (**Remembering**)

CO3: Discuss various transitions of Photochemistry with reference to cis- trans isomerisation and Di-Pi methane rearrangement, Norrish type-I and type II reactions, Paterno Bucchi reactions & photochemistry of nitrites (**Understanding**).

4. Course Content

MODULE I: REACTION MECHANISM –II AND MOLECULAR REARRANGEMENTS (15Hrs)

Neighbouring group participation: Criteria for determining the participation of neighbouring group. Enhanced reaction rates, retention of configuration, isotopic labeling and cyclic intermediates. Neighbouring group participation involving Halogens, Oxygen, Sulphur, Nitrogen, Aryl, Cycloalkyl groups, σ and π -bonds. Introduction to nonclassical carbocations (stereospecific examples of NGP to be covered in conformational analysis)

Reactive Intermediates: Generation, detection, structure, stability and reactions of carbenes and nitrenes.

Molecular rearrangements: Definition and classification. Molecular rearrangements involving

1) electron deficient carbon: Allylic and Wolf rearrangement.

2) electron deficient Nitrogen: Lossen, Curtius and Schmidt 3) electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalysed rearrangements: Benzilic acid, Favourski, Transannular, Sommelet-Hauser and Smiles rearrangement

MODULE II: PERICYCLIC REACTIONS

(15 hrs)

Introduction, Classification of pericyclic reactions,

Electrocyclic reactions: con rotation and dis rotation. Electrocyclic closure and opening in $4n$ and $4n+2$ systems.

Cycloaddition reactions: suprafacial and antarafacial additions in $4n$ and $4n+2$ cycloadditions.

Sigmatropic reactions: [i, j] shifts- suprafacial and antarafacial shifts, Cope and Claisen rearrangement reactions.

Approaches for the interpretation of mechanism of pericyclic reactions: Aromatic Transition States (ATS)/Perturbation Molecular Orbitals (PMO) approach-Concept of Huckel – Mobius aromatic and antiaromatic transition states. Framing Woodward-Hofmann selection rules for all the pericyclic reactions by ATS approach. Solving problems based on ATS approach.

Molecular orbitals: ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene, allyl cation, allyl radical, pentadienyl cation, pentadienyl radical.

Frontier Molecular Orbital (HOMO-LUMO) approach-concept: Framing Woodward-Hofmann selection rules for all the pericyclic reactions by Frontier Molecular Orbital (FMO) approach. Solving problems based on FMO approach.

Conservation of orbital symmetry: (Correlation Diagrams) approach- for electrocyclic and cycloadditions & cycloreversions

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MODULE III: PHOTOCHEMISTRY (15 hrs)

Photochemistry of π - π^* transitions: Excited states of alkenes, cis-trans isomerisation, and photo stationary state. Photochemistry of 1,3-butadiene, di- π methane rearrangement. Intermolecular reactions, photocycloadditions, photodimerisation of simple and conjugated olefins. Addition of olefins to α , β -unsaturated carbonyl compounds. Excited states of aromatic compounds, Photoisomerisation of benzene.

Photochemistry of (n- π^*) transitions: Excited states of carbonyl compounds, homolytic cleavage of α - bond, Norrish type I reactions in acyclic and cyclic ketones and strained cycloalkane diones.

Intermolecular abstraction of hydrogen: photoreduction-influence of temperature, solvent, nature of hydrogen donor and structure of the substrate.

Intramolecular abstraction of hydrogen: Norrish type II reactions in ketones, esters and 1,2 diketones, Addition to carbon-carbon multiple bonds, Paterno-Buchi reaction, Photochemistry of nitrites-Barton reaction.

5. References

1. Stereochemistry of Carbon compounds by Ernest L Eliel / Samuel H. Wilen
2. Stereochemistry of organic compounds – Principles and Applications by D Nasipuri
3. The third dimension in organic chemistry, by Alan Bassindale
4. Stereochemistry: Conformation and Mechanism by P S Kalsi
5. Stereochemistry by V M Potapov
6. Advanced Organic Chemistry by Jerry March
7. Mechanism and Structure in Organic Chemistry S. Mukerjee
8. Maya Shanker Singh Reactive Intermediates inorganic Chemistry –Structure, mechanism and Reactions, Wiley –VCH, 2012.
9. Organic chemistry Vol.I and II by I.L.Finar
10. Comprehensive organic chemistry Vol.5 D.H.R.Barton and W.D..Ollis
11. Pericyclic reactions A textbook: reactions by Ian Fleming.
12. Pericyclic reactions- A textbook: reactions, applications and theory by Shankararaman
13. Organic photochemistry by J.M. Coxon and B, Hatton
14. Introduction to organic Photochemistry by J. D. Coyle
15. Modern Molecular Photochemistry of Organic Molecules by N J Turro, V. Ramaswamy and J C Scaiano

1. Syllabus Focus

a) Relevance to Local , Regional , National and Global Development Needs

Local /Regional/National /Global Development Needs	Relevance
Local	Knowledge of the reaction mechanisms involved may make it possible to choose reaction conditions favouring one path over another in in pharma industry .
Regional	Deepening the knowledge of photochemical and photophysical properties of chemical compounds and materials and its implementation in the formulation of photostabilizers and skin-protective sun lotions and creams
National	The study of reaction mechanisms plays a central role in advancing our understanding of chemical reactivity and in the development of new materials, pharmaceuticals, and technologies.
Global	Numerous life processes depend heavily on pericyclic reactions. For instance, prephenate is produced when chorismate experiences a cycloaddition reaction in <i>Escherichia coli</i> . The epidermis undergoes a [1,7]-sigmatropic process to produce vitamin D.

b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
ED	Reaction Mechanism	Developing new reaction mechanisms that offer advantages over traditional methods. This could involve improved selectivity, higher yields, or reduced environmental impact.
EMP	Photochemistry	Design and implement practical laboratory experiments that allow students to apply photochemical principles.
SD	Pericyclic reactions	Solving theoretical problems and interpreting results

2. Pedagogy

S. No	Student Centric Methods Adopted	Type / Description of Activity
1.	Participative Learning	Seminars/Assignment
2.	Experiential Learning	Science Experiments
3.	Case studies	Problem solving

3. Course Assessment Plan

a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments CIA -40%	End Semester Examination-60%
CO1	CIA1-Written Exam	Written Exam
CO2	Skill Test-I – Assignment	
CO3	Skill Test-II - Problem solving	

b) Model Question Paper- End Semester Exam

ORGANIC CHEMISTRY-II MODEL QUESTION PAPER THEORY

Course Code: P24/CHE/DSC/202

Max Marks:60

Credits: 3

SECTION A

I Answer the following Questions

3 x 12 = 36 M

1. a) Explain NGP involving Halogens (CO1) (Level-5)
- b) Discuss geometry and generation methods of carbene (CO1) (Level-1) .

OR

2. Outline the mechanism of following rearrangements (CO1) (Level-2)
 - i) Baeyer -Villiger rearrangement
 - ii) Benzilic acid rearrangement

3. a) List the selection rules for sigmatropic reactions by ATS approach (CO2) (Level-1)
- b) Describe Claisen rearrangement with examples. (CO2) (Level-2)

OR

- 4.a) Write all the molecular orbitals of pentadienyl cation, indicate their Frontier Molecular

Orbitals in ground state and First Excited state (CO2) (Level-1)

b) Write all the selection rules for electrocyclic reactions? Explain them by FMO method

(CO2)(Level-1)

5. a) Write about photodimerization reactions (CO3) (Level-1)

b) Write about di- π methane rearrangement. (CO3) (Level-1)

OR

6. a) Illustrate Norrish type I and type II cleavage process (CO3) (Level-2)

b) Explain the Photoisomerisation of benzene. (CO3) (Level-5)

II Answer any FOUR

4 x 6 = 24 M

7. Explain the reactivity of Nitrenes. (CO1) (Level-5)

8. Outline the mechanism of Sommelet-Hauser rearrangement (CO1) (Level-2).

9. Write all the molecular orbitals of 1, 3 Butadiene. Indicate HOMO and LUMO under Ground state and First Excited state. (CO2) (Level-1)

10. List the selection rules of cycloaddition reactions based on PMO approach. (CO2) (Level-1)

11. What is Barton reaction? Explain its mechanism. (CO3) (Level-1)

12. Outline the mechanism of Paterno Buchi reaction. (CO3) (Level-2)

c) Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1.	15	1	2	12	2	4 x 6 = 24
2.	15	2	2	12	2	
3.	15	3	2	12	2	

4. CO-PO Mapping

CO	PO	Cognitive Level	Class room sessions (hrs)
1	1	Evaluation	15
2	2	Evaluation	15
3	5	Application	15

b) Model Question Paper- End Semester Exam

**ORGANIC CHEMISTRY-II
MODEL QUESTION PAPER
THEORY**

Course Code: P24/CHE/DSC/202

Max Marks:60

Credits: 3

SECTION A - INTERNAL CHOICE		3Q X 12 M = 36 M		
Question Number	Module	Question	CO	BTL
1	Module 1	a) Explain NGP involving Halogens b) Describe geometry and generation methods of carbene	CO 1	Level II Level I
2	Module 1	Outline the mechanism of following rearrangements i) Baeyer -Villiger rearrangement ii) Benzilic rearrangement	CO 1	Level II
3	Module 2	a) Outline the selection rules for sigmatropic reactions by ATS approach b) Explain Claisen rearrangement with examples.	CO 2	Level II Level II
4	Module 2	a) List all the molecular orbitals of pentadienyl cation, indicate their Frontier Molecular Orbitals in ground state and First Excited state b) List all the selection rules for electrocyclic reactions? Explain them by FMO method	CO 2	Level I Level I
5	Module 3	a) Explain photodimerization reactions b) Outline di- π methane rearrangement.	CO 3	Level II Level II


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6	Module 3	a) Illustrate Norrish type I and type II cleavage process b) Explain the Photo isomerisation of benzene.	CO 3	Level II Level II
SECTION B - ANSWER ANY 4 OUT OF 6				
			4 Q X 6 M = 24 M	
(To compulsorily have Two questions from each module)				
7	Module 1	Explain reactivity of Nitrenes.	CO 1	Level II
8	Module 1	Outline the mechanism of Sommelet-Hauser rearrangement	CO 1	Level II
9	Module 2	Draw all the molecular orbitals of allene and indicate HOMO and LUMO under Ground state and First Excited state.	CO2	Level IV
10	Module 2	Outline the selection rules of cycloaddition reactions based on PMO approach.	CO 2	Level II
11	Module 3	What is Barton reaction? Explain its mechanism.	CO 3	Level I
12	Module 3	Outline the mechanism of Paterno Buchi reaction.	CO3	Level II

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Dept of Chemistry
Osmania University, Hyd-07.


Head
Department of Chemistry
Osmania University
Hyderabad-500 06.

PRACTICAL SYLLABUS CBCS-2020**SEMESTER -I****ORGANIC CHEMISTRY****Course Code:** P24/CHE/DSC/102/P**Max. Marks:** 50**Course:** DSC-2**Hours per week:** 4 Hrs**No. of Credits:** 2**COURSE OBJECTIVES**

- To study the systematic analysis of functional group present in an organic compound

COURSE OUTCOMES

CO1: Identify various functional groups present in the given organic compound by using a systematic procedure.

CO2: Get familiarize with solubility nature of organic substances of different functional groups

CO3: To get acquainted with the tests involved in identification of various functional groups

Identification of organic compounds systematic qualitative analysis:

Physical data BP / MP, Ignition test, solubility classification, Extra elements-N,S & Halogens, (Lassaigne sodium fusion test, Beilstein test)

Functional groups tests, Preparation of crystalline derivative and determination of their m.p.s and reference to literature to identify the compounds

A minimum of 8 following compounds to be studied as unknown covering atleast one from each of the solubility classes

-Naphthol; Aniline, o/m/p-Chloroanilines; N-Methyl aniline/N-Ethylaniline, N,N-Dimethylaniline, Benzamide, Benzaldehyde, Anisaldehyde, Acetophenone, benzophenone, Ethylbenzoate, methylbenzoate, Nitrobenzene, chlorobenzene, bromobenzene, naphthalene, biphenyl anthracene, Glucose, benzoic acid, 2-chloro benzoic Acid, Anisic acid, p-Nitrobenzoic acid; p-Cresol, p-Chlorophenol,

REFERENCE BOOKS

- Text book of practical organic chemistry, Vogel
- Text book of practical organic chemistry, Mann and Saunders.




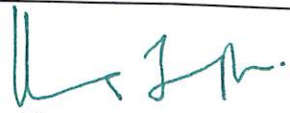
3. Spectral identification of organic compounds Bassler, Silverstein 5th Edition.

**SEMESTER II
ORGANIC CHEMISTRY-II
MODEL PRACTICAL QUESTION PAPER**

Course Code: P20/CHE/DSC/202/P
Credits : 2

Time: 3Hrs
Max. Marks:50

1. Write the tests involved in the identification of weak acids. (CO1) 10 M
2. Identify the functional group present in the given organic compound by a study of its Solubility Behaviour, ignition and confirmatory tests. Determine its b.p/m.p and submit the derivative.(CO2) 25 M
3. Record + Attendance 5 M
4. Viva voce (CO3) 10 M

Prepared by Course Teacher [Name & Signature]	Checked & verified by HOD [Name & Signature]	Approved by the Principal
 Dr.M.Bhargavi  Dr. Sabiha Fatima	 Dr.D.Sumalatha	 Dr.Uma Joseph

SEMESTER - II
PHYSICAL CHEMISTRY-II

1. Course Description

Programme: M.Sc. Organic Chemistry
Course Code: P24/CHE/DSC/203
Course Type: DSC-3
No. of credits: 3

Max. Hours: 45
Hours per week: 3
Max. Marks: 100

2. Course Objectives

- To describe the theories of reaction rates, complex reactions, and linear free energy relationships. To determine the quantum yields, and photo-physical kinetics of unimolecular reactions.
- To apply radial and angular functions to orbitals, to discuss approximate methods of many-electron systems, to demonstrate MO theory and VB theory.
- To describe the electronic properties of solids, to explain superconductivity, to prepare and characterize nanoparticles.

3. Course Outcomes

CO1: Discuss different theories of reaction rates, explain Hammett and Taft equation, interpret quantum yields and photo-physical kinetics of unimolecular reactions. (UNDERSTANDING)

CO2: Calculate Schrodinger's wave equation for hydrogen atom; use variation principle to various molecules, compare MO and VB models. (APPLICATION)

CO3: Explain the band theory of metals, insulators, and semiconductors; describe the theories of superconductivity; classify super conductors; explain the preparation and characterization of nanoparticles. (UNDERSTANDING)

4. Course Content

MODULE I: CHEMICAL KINETICS & PHOTOCHEMISTRY

(15 Hrs)

Chemical Kinetics: Theories of reaction rates: Collision theory, steric factor. Transition state theory. Hammond's postulate. Thermodynamic formulation of transition state theory. Activation parameters and their significance The Eyring equation Unimolecular reactions and Lindemann's theory.

Complex reactions: Opposing reactions, parallel reactions, and consecutive reactions (all first order type). Chain reactions-general characteristics, steady state treatment. Example- H_2-Br_2 reaction. Derivation of rate law.

Effect of structure on reactivity: Linear free energy relationships. Hammett and Taft equations- substituent (σ and σ^*) and reaction constant (ρ and ρ^*) with examples. Deviations from Hammett correlations, reasons- Change of mechanism, resonance interaction. Taft four parameter equation

Photochemistry: The Franck Condon principle; Electronically excited molecules- singlet and triplet states. Radiative lifetimes of excited states-theoretical treatment; Measured lifetimes; Quantum yield. Derivation of fluorescence and phosphorescence quantum yields.

Photo physical processes - Photophysical kinetics of unimolecular reactions. Calculation of rate constants of various photo physical processes-problems.

Photosensitization. Quenching-Stern-Volmer equation. Introduction to fast reactions- Principle of flash photolysis.

MODULE II: QUANTUM CHEMISTRY-II

(15 Hrs)

Cartesian, Polar and spherical polar coordinates, and their interrelations, Schrodinger equation for the hydrogen atom- separation into three equations. Hydrogen like wave functions; Radial and angular functions; Quantum numbers n , l and m and their importance. The radial distribution functions. Hydrogen like orbitals and their representation; Polar plots, contour plots and boundary diagrams.

Many electron systems: Approximate methods. The variation method-variation theorem and its proof. Trial variation function and variation integral. Examples of variational calculations Particle in a box Construction of trial function by the method of linear combinations. Variation parameters Secular equations and secular determinant.

Bonding in molecules: Molecular orbital theory-basic ideas; Construction of MOs by LCAO, H_2^+ ion; The variational integral for H_2^+ ion; Detailed calculation of Wave functions and energies for the bonding and antibonding MOs. Physical picture of bonding and antibonding wave functions; Energy diagram. The MO wave function and the energy of H_2 molecule MO by LCAO method and Valence bond method (detailed calculations not required)-comparison of MO and VB models.

MODULE III: SOLID STATE CHEMISTRY

(15 Hrs)

Electronic properties of metals, insulators, and semi-conductors: Electronic structure of solids, Band theory, Fermi level, K space and Brillouin Zones, band structure of metals, insulators and semi-conductors; Electrons, holes and Excitons; The temperature dependence of conductivity of extrinsic semi-conductors; Photo conductivity and photovoltaic effect – p-n junctions.

Superconductivity: Occurrence of superconductivity; Destruction of superconductivity by magnetic fields – Meissner effect; Types of superconductors; Theories of superconductivity – BCS theory. High temperature superconductors: Structure of defect perovskites. High T_c superconductivity in cuprates; Phase diagram of Y-Ba-Cu-O system; Crystal structure of YBa₂Cu₃O_{7-x}. Preparation of 1-2-3 materials; Origin of high T_c superconductivity.

Nanoparticles and their applications:

Introduction to nanoparticles; Reduced dimensionality in solids, systems with various dimensions-examples. Preparation of nano particles –top down and bottom-up methods. Preparation of nanomaterials- sol gel methods, and chemical vapour deposition method; thermolysis; Characterization of nanoparticles – experimental methods – powder X-ray diffraction, Transmission Electron Microscopy (TEM), and Atomic Force Microscopy (AFM) (detailed theory and instrumentation are not required). Optical properties of nanoparticles, Application of nanoparticles

5. References

1. Physical Chemistry-A Molecular approach. D.A. McQuarrie and J.D. Simon, Viva Books Pvt Ltd
2. Elements of Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press
3. Chemical Kinetics and Reaction Mechanisms, J. H. Espenson, McGraw Hill
4. Chemical Kinetics KI I nidler, MoGrow Hill
5. The Physical Basis of Org. Chemistry by Howard Maskill, Oxford Univ. Press (New York)
6. Fundamentals of Photochemistry, K.K.Rohtagi-Mukherji, Wiley-Eastern
7. Molecular Reactions and Photo chemistry by Depuy and Chapman
8. Molecular Photochemistry, N.J. Turro, Benjamin
9. Photochemistry, R.P.Kundall and A. Gilbert, Thomson Nelson
10. Essentials of Molecular Photochemistry by A. Gilbert and J. Baggott, Blackwell Scientific Publications.
11. Organic Photochemistry by J.M.Coxon and B.Halton, Cambridge University press.
12. Introductory Photochemistry by A.Cox and T.J.Kemp. McGraw-Hill, London.
13. Quantum Chemistry, D.A. McQuarrie, Prentice Hall
14. Quantum Chemistry, Ira N. Levine, Prentice Hall
15. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill
16. Quantum Chemistry, RK Prasad, New Age International Pvt Ltd Publishers
17. Elementary Quantum Chemistry, F. L. Pilar, McGraw Hill.
18. Introduction to Solids, Leonid V. Azaroff, Tata McGraw Hill
19. Solid state Chemistry, D.K. Chakrabarthy, New Age International
20. Solid state Chemistry and its applications, A.R. West, Plenum.
21. Principles of the Solid State, H. V. Keer, New Age International
22. The physics and chemistry of solids by Stephen Elliott, Wiley Publishers.
23. Nanostructured Materials and Nanotechnology, edited by Hari Singh Nalwa, Acad. Press
24. Self-Assembled Nanostructures, Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen & Gan-Yu-Liu, Kluwer Academic/Plenum
25. Introduction to Nanotechnology. Charles P. Poole Jr, F. J. Owens, Wiley India Pvt. Ltd.

1. Syllabus Focus

a) Relevance to Local, Regional, National and Global Development Needs

Local /Regional/National /Global Development Needs	Relevance
LOCAL	Optimizing local industrial processes, usage of photochemical industries, understanding the MO and VB models, developing new materials
REGIONAL	Reactions contributing to regional air quality, drive innovation in computational chemistry, innovation in the development of nanomaterials
NATIONAL	Ensure the health of ecosystems by applying chemical kinetics and photochemistry, fostering innovation in healthcare, development of materials used in fuel cells
GLOBAL	Initiatives addressing environmental issues with an understanding of chemical kinetics and photochemistry, broad implications for industries and technologies, development of smaller and more efficient electronic devices

b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
SD	Module No. 1	Encompassing theoretical knowledge, and numericals on quantum yields
ED	Module No.2	Invite entrepreneurs, professionals, or researchers who apply quantum chemistry to share their experiences and insights
EMP	Module No. 3	Encourage critical thinking on research methodologies and applications from publications in journals

2. Pedagogy

S. No	Student Centric Methods Adopted	Type / Description of Activity
1.	Problem Solving	Case studies
2.	Experiential Learning	Field Trips
3.	Participative Learning	Presentation

3. Course Assessment Plan**a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination**

CO	Continuous Internal Assessments CIA - 40%	End Semester Examination-60%
CO1	CIA-1 - Written Exam	Written Exam
CO2	CIA-2 - Presentation	
CO3	CIA-2 - Assignment	

SECTION A - INTERNAL CHOICE			3 Q X 12 M = 36 M	
Question Number	Module	Question	CO	BTL
1	Module 1	(a) Derive Eyring equation. (b) Write the mechanism of H_2-Br_2 reaction and derive the rate law.	CO 1	(Level-II) (Level-II)
2	Module 1	(a) Derive Stern-Volmer equation. (b) Explain photophysical Kinetics of unimolecular reactions.	CO 1	(Level-II) (Level-II)
3	Module 2	(a) Write the Schrodinger wave equation for the hydrogen atom and separate it into three equations. (b) State and explain variation theorem.	CO 2	(Level-I) (Level-II)
4	Module 2	(a) Explain i) Polar plots ii) Counter plots iii) Boundary diagram. (b) Explain the M.O treatment of H_2^+ ion.	CO 2	(Level-II) (Level-II)
5	Module 3	(a) Discuss BCS theory of superconductivity. (b) Explain preparation of nanoparticles-Top down and bottom-up method.	CO 3	(Level-I) (Level-II)
6	Module 3	(a) Describe the Phase diagram of the Y-Ba-Cu-O system. (b) Describe the sol-gel method for the preparation of nanomaterials.	CO 3	(Level II) (Level II)
SECTION B - ANSWER ANY 4 OUT OF 6 (To compulsorily have Two questions from each module)			4Q X 6 M = 24 M	
7	Module 1	Explain the collision theory of reaction rates.	CO 1	(Level-II)
8	Module 1	Derive an expression for the quantum yield of phosphorescence.	CO 1	(Level-II)
9	Module 2	Explain secular equations and secular determinants.	CO 2	(Level-II)
10	Module 2	Compare MO and VB concepts of bonding taking H_2 as an example.	CO 2	(Level II)
11	Module 3	Explain Meisner's effect. What is its significance?	CO 3	(Level-II)
12	Module 3	Explain the characterization of nanoparticles using AFM.	CO 3	(Level-II)

b) Model Question Paper - End Semester Exam**PHYSICAL CHEMISTRY-II
MODEL QUESTION PAPER
THEORY****Course Code: P24/CHE/DSC/203****Max Marks:60****Credits: 3****Max Hours:2½hrs****SECTION-A****I Answer the following questions****3X12=36 Marks****1. (a) Derive Eyring equation. (CO1) (Level II)****(b) Write the mechanism of H₂-Br₂ reaction and derive the rate law. (CO1) (Level II)****OR****2. (a) Derive Stern-Volmer equation. (CO1) (Level II)****(b) Explain photophysical Kinetics of unimolecular reactions. (CO1) (Level II)****3. (a) Write the Schrodinger wave equation for the hydrogen atom and separate it into three equations (CO2) (Level I)****(b) State and explain variation theorem. (CO2) (Level II)****OR****4. (a) Explain i) Polar plots ii) Counter plots iii) Boundary diagram. (CO2) (Level II)****(b) Explain the M.O treatment of H₂⁺ ion. (CO2) (Level II)****5. (a) Discuss BCS theory of superconductivity. (CO3) (Level I)**

(b) Explain preparation of nanoparticles-Top down and bottom-up method. (CO3) (Level II)

OR

6. (a) Describe the Phase diagram of the Y-Ba-Cu-O system. (CO3) (Level II)

(b) Describe the sol-gel method for the preparation of nanomaterials. (CO3)
(Level II)

SECTION-B

II Answer any four questions

4 X 6 = 24 M

7. Explain the collision theory of reaction rates. (CO1) (Level II)

8. Derive an expression for the quantum yield of phosphorescence. (CO1) (Level II)

9. Explain secular equations and secular determinants. (CO2) (Level II)

10. Compare MO and VB concepts of bonding taking H₂ as an example. (CO2) (Level II)

11. Explain Meisner's effect. What is its significance? (CO3) (Level II)

12. Explain the characterization of nanoparticles using AFM. (CO3) (Level II)

c) Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	1	2	12	2	4 x 6 = 24
2	15	2	2	12	2	
3	15	3	2	12	2	

4. CO-PO Mapping

CO	PO	Cognitive Level	Classroom sessions(hrs)
1	1	Understanding	15
2	5	Evaluating	15
3	6	Create	15

SEMESTER-II PRACTICALS**CHEMISTRY LAB: DSC- 3****LAB: PHYSICAL CHEMISTRY**

Program: M.Sc.

Subject Code P24/CHE/DSC/203/P

Course: DSC-3

No. of Hrs. allotted: 4 Hrs / week

Semester: II

No. of Credits : 2

COURSE OBJECTIVES:

- To determine the rate constants, stoichiometry, and order of various reactions
- To apply the instrumentation techniques like conductometry, pH-metry and potentiometry in various titrations
- To determine the acid catalysed inversion of cane sugar using a polarimeter

COURSE OUTCOMES:

This course will help the students to

CO1:Analyze the overall order of various reactions, distribution coefficient of I₂**CO2:** Determine the concentration of acids using a conductometer, pH-meter and precipitation titration using a potentiometer.**CO3:** Perform the acid catalysed inversion of cane sugar using a polarimeter.**Lab course 3****Physical Chemistry****4 hrs/week**

- I. **Data analysis II:** Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.
- II. **Distribution:**

1. Distribution of I₂ between cyclohexane and water
2. Distribution of I₂ between cyclohexane and aq. KI solution - calculation of equilibrium constant.
- III. Chemical Kinetics:**
 3. Stoichiometry of Peroxydisulphate - Iodide reaction
 - 4,5. Peroxydisulphate - Iodide reaction: Comparison of strengths of KI solutions by isolation method
- IV. Conductometry:**
 6. Titration of a mixture of strong and weak acids vs strong base
 7. Determination of the hydrolysis constant of aniline hydrochloride
 8. Determination of solubility product
- V. Potentiometry:**
 9. Titration of Cl⁻ vs Ag⁺ (precipitation titration)
 10. Determination of solubility product of sparingly soluble salt
- VI. Polarimetry:**
 11. Inversion of cane sugar catalyzed by 1N HCl
 12. Inversion of cane sugar catalyzed by 2N HCl
- VII. pH metry:**
 13. Calibration of a pH meter and preparation of phosphate buffers
 14. Titration of strong acid vs strong base
 15. Titration of weak acid vs strong base and determination of dissociation constant of weak acid

References:

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
2. Experimental Physical Chemistry: V. Athawale and P. Mathur.
3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.
4. Practical in Physical Chemistry: P.S. Sindhu
5. Advanced Practical Physical chemistry: J.B. Yadav

Chairperson

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**PHYSICAL CHEMISTRY
PRACTICAL MODEL PAPER**

Course Code: P24/CHE/DSC/203/P
Credits: 2

Max Time:3hrs
Max marks :50 marks

Answer all questions.

1. Write the Principle involved in the given experiment. (CO1, CO2, CO3) 10 M
2. a) Determine the strength of the given acid using a Conductometer/pH-meter. (CO2)
OR
b) Determine the inversion of cane sugar using a polarimeter (CO3).
OR
c) Determine the strength of KI by an isolation method. (CO1)
OR
d) Determine the strength of AgCl using a potentiometer. (CO2)
OR
d) Determine the concentration of KI using the distribution coefficient of I_2 between cyclohexane and aq. KI solution. (CO1) 25 M
3. Record and Attendance 5 M
4. Viva Voce (CO1, CO2, & CO3) 10 M

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