ST. FRANCIS COLLEGE FOR WOMEN, BEGUMPET
(Autonomous & affiliated to Osmania University)
Faculty of Science – Department of Chemistry
THEORY SYLLABUS CBCS-2026
SEMESTER –II
Paper Title: Analytical Chemistry-II

Programme: M.Sc. **Course Code: P26/CHE/DSC/204/L** **Type of course: Discipline Specific Core**	**Max. Hours: 60** **Hours per week: 4** **Max. Marks: 100** **No. of credits: 4**
Module 1: **Electro and thermal analytical techniques**	
Module 2: **NMR Spectroscopy -II**	
Module3: **Mass spectrometry**	
Module4: **Photoelectron & ESR Spectroscopy**	

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ANALYTICAL CHEMISTRY-II

1. Course Description

Programme: M.Sc. Organic Chemistry
Course Code: P26/CHE/DSC/204 /L
Course Type: Discipline Specific Core
No. of credits: 4

Max. Hours : 60
Hours per week: 4
Max. Marks: 100

2. Course Objectives

1. To learn Basic and Advanced Electro-analytical techniques
2. To understand basics and applications of ^{1}H,^{19}F and ^{31}P NMR in organic compounds
3. To apply techniques of Mass Spectroscopy to determine fragmentation, and molecular weight, and learn advanced mass spectroscopic techniques like FAB, SIMS, MALDI etc.
4. To understand the principles and applications of Photoelectron Spectroscopy and ESR Spectroscopy in studying electronic structure, free radicals, and transition metal complexes.

3. Course Outcomes

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

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

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

CO4:Understand the principles, techniques, and applications of Photoelectron Spectroscopy (UPS, XPS, ESCA, Auger) and ESR spectroscopy to interpret binding energies, molecular spectra, free radicals, and the electronic structure and covalency in transition metal complexes.

Expected Level of Output: Conceptual level

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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. Polargraphy

(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 SO42-, metal ions viz., Mg2+, Zn2+, Cu2+ and other substances.

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

II: Thermal Analysis: Thermal Techniques-Introduction, types of thermos-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 Spectroscopy-II **(15 Hrs)**

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

First order and non-first order spectra e.g., AX, AX_2, AX_3, A_2X_3, 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, [η^1-C_5H_5M], [η^5-$(C_5H_5)_2Ti$ η^1-$(C_5H_5)_2$].

^{19}F NMR spectroscopy: ^{19}F chemical shifts, coupling constants. Applications of ^{19}FNMR involving coupling with^{19}F,^{1}H and ^{31}P: 1,2dichloro-1,1-difluoroethane, BrF_5, SF_4, PF_5, ClF_3, IF_5, CF_3CH_2OH.

^{31}P NMR spectroscopy: ^{31}P chemical shifts, coupling constants. Application of ^{31}P NMR involving coupling with ^{31}P,^{19}F,^{1}H and ^{13}C: ATP, Ph_3PSe, P_4S_3, H_3PO_4, H_3PO_3, H_3PO_2, HPF_2, PF_6^-, PH_3, [Rh (PPh_3) Cl] (Rh I=1/2)

IKS Component : NMR Spectroscopy -II

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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, metastable ion peaks. Principle of EI, CI, Fast Atom Bombardment (FAB), Secondary Ion Masspectrometry (SIMS), Thermospray (TSI) ionization, and Matrix Assisted Laser Desorption Ionization (MALDI) methods. High resolution mass spectrometry.
Fragmentation pattern of organic compounds: cleavage of one, two or more bonds, β-cleavage, McLafferty rearrangement, retro Diels–Alder fragmentation, ortho effect, dehydration, dehydrohalogenation, decarboxylation and elimination of NO. Determination of molecular formula.

IKS Component : Mass Spectrometry

Module 4: Photoelectron & ESR Spectroscopy **(15Hrs)**

Photoelectron Spectroscopy
Principle, types of Photoelectron Spectroscopy UPS & XPS. Binding Energies, Koopman's Theorem, Chemical Shifts. Photoelectron Spectra of Simple Molecules: N_2, O_2, F_2, CO. ESCA in qualitative analysis. Principles of Auger electron spectroscopy.

ESR Sprectroscopy
Introduction, principle, selection rules, interpretation of Lande's factor 'g'.Hyperfine and super hyperfine Coupling. Anisotropy in 'g' values and hyperfine coupling constants. Zero field splitting, Kramer's degeneracy and quadrupolar interactions. Study of free radicals and transition metal complexes. Evidence for covalency in complexes, Ex.:-Cu(II) Bis -salcylaldimine, Bis-acetyl acetanato vanadyl(II) and hexachloroiridium(IV) complexes.

5. Reference Books

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

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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 1. Fleming McGraw-Hill Education

6. 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

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b. Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
SD	Module 1	Present real-world industry problems related to analytical techniques, and discuss the solutions with students
ED	Module 2	Invite successful entrepreneurs in the field to share their experiences, challenges and insights
EMP (NSQF Level 4,5,6 & 7)	Module 3	Helping students gain practical experience and exposure to real-world applications
SD	Module 4	Gain practical proficiency in handling instruments to identify and study paramagnetic species such as free radicals and transition metal ions.

c. IKS Components

IKS	Syllabus Content	Module
IKS	Dropping Mercury Electrode (DME)	I
IKS	NMR-II	2
IKS	Mass Spectrometry	3

d. Alligned with SDG 6 (Clean Water) SDG 12 (Responsible Consumption), SDG 7(Affordable & Clean Energy),SDG 3(Good Health & Well-being), SDG 15 (Life on Land).

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7. 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
4.	Peer teaching	Students develop mini-lessons to present to their peers on given subjects.

8. Course Assessment Plan

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

Maximum Marks: 20M		**Maximum Marks: 20M**	
CIA 1 **Subjective**	**CIA 1** **Subjective**	**CIA 2** **Skill Based Test: 10M**	**CIA 2** **Assignment: 10M**
Section A: 1x10=10M Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	**Section A: 1x10=10M** Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	Discretion of the faculty	Discretion of the faculty

External QP Pattern		
4 Credits 4 Modules (CORE)	SECTION A - Internal Choice	**4 Q X 10 M = 40M**
	SECTION B – Answer any 5 out of 8 (To compulsorily have ONE question from each module)	**5 Q X 4 M = 20M**

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b) Aligning COs with Continuous Internal Assessments

Cos	Continuous Internal Assessments - CIA (40%)	End Semester Examination - (60%)
CO1	CIA-2 Assignment	End Semester examination
CO2	CIA-1	
CO3	CIA-1	
CO4	CIA-2 Presentation, Quiz	

c. Question Paper Pattern:

St. Francis College for Women, Begumpet
Faculty of Science – Department of Chemistry
ABSTRACT MODEL PAPER
END SEMESTER EXAM

Subject Code: P26/CHE/DSC/204/L
Time: 2½ h **Max marks: 60**

SECTION – A

Answer all questions **(4X10=40 M)**

1. (a).
   (b).
   (OR)
2. (a).
   (b).
3. (a).
   (b).
   (OR)
4. (a).
   (b).
5. (a).
   (b).
   (OR)
6. (a).
   (b).
7. (a).
   (b).
   (OR)
8. (a).
   (b).

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SECTION - B

Answer any 5 of the following questions **(5X4 =20 M)**

9.
10.
11.
12.
13.
14.
15.
16.

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Model Question Paper - End Semester Exam

ANALYTICAL CHEMISTRY-II
MODEL QUESTION PAPER
THEORY

Course Code: P26/CHE/DSC/204 /L **Max Marks:60**
Credits: 4 **Max Hours:2½hrs**

SECTION-A

I Answer the following questions **4X12=40 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-2**
   b) Write a short note on Pulse Polarography and Square Wave Polarography. **(CO1) (Level I)**

3 . a) Predict The ^{1}H NMR Spectra of AMX and ABC type. **(CO2) Level-2** b) What Is NOE? Discuss any one 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-2**
   b) Discuss applications ^{19}F NMR. **(CO2) Level-2**

5. a) Explain Mclafferty rearrangement using a suitable example **(CO3) Level-2**
   b) Write notes on the mass fragmentation pattern of carbonyl compounds. **(CO3) Level-1**

OR

6. a) Write the principle and applications involved in GC –MS **(CO3) Level-1**
   b) What is the ortho effect and how is it useful in mass spectrometry? **(CO3) Level-1**

7. a) Sketch the photoelectron spectra of N_2 molecule **(CO4) Level-2**
   b) Explain the ESR spectrum of hexachloroiridium(IV) complexes. **(CO4) Level-2**

OR

8. a) What is Kramer's degeneracy? Explain with suitable example. **(CO4) Level-1**
   b) What is hyperfine and super hyperfine coupling? Explain with suitable examples. **(CO4) Level-1**

SECTION-B

II Answer any <u>five</u> questions **5 X 4 = 20 M**

9. What is the role of DME in polarography explain with diagram. (CO1) **Level-2**
10. Explain different types of Amperometric titration with suitable examples. (CO1) **Level-2**
11. How do you discriminate enantiomers by using chiral Mosher's acid? (CO2) **Level-1**
12. Describe the ^{31}P NMR spectra of H_3PO_4 and H_3PO_3. (CO2) **Level-2**
13. Discuss the Retro-Diels-Alder fragmentation pattern with examples. (CO3) **Level-2**
14. Write about MALDI (CO3) **Level-1**
15. Explain the Koopman's theorem. (CO4) **Level-1**
16. Explain the principle and selection rules of ESR. (CO4) **Level-1**

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SECTION A - INTERNAL CHOICE			4 Q X 10 M = 40 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. **OR**	CO 1	Level-2 Level-1
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-2 Level-1
3	Module 2	(a) Predict The ^{1}H NMR Spectra of AMX and ABC type. (b) What Is NOE? Discuss any one of its applications. **OR**	CO 2	Level-2 Level-1
4	Module 2	(a) Explain the simplification of NMR spectra by any two instrumental techniques. (b) Discuss applications ^{19}F NMR.	CO 2	Level-1 Level-2
5	Module 3	(a) Explain Mclafferty rearrangement using a suitable example (b) Write notes on the mass fragmentation pattern of carbonyl compounds. **OR**	CO 3	Level-2 Level-1
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-2 Level-2
7	Module 4	(a) Sketch the photoelectron spectra of N_2 molecule (b) Explain the ESR spectrum of hexachloroiridium(IV) complexes. **OR**	CO4	Level-2

8	**Module 4**	(a) What is Kramer's degeneracy? Explain with suitable example. **(CO4) (Level I)** (b) What is hyperfine and super hyperfine coupling? Explain with suitable examples. **(CO4) (Level I)**	**CO4**	**Level-2**
SECTION B - ANSWER ANY 5 OUT OF 8 (To compulsorily have Two questions from **each** module)			**5Q X 4 M = 20 M**	
9	**Module 1**	What is the role of DME in polarography explain with diagram.	**CO 1**	**Level-2**
10	**Module 1**	Explain different types of Amperometric titration with suitable examples.	**CO 1**	**Level-2**
11	**Module 2**	How do you discriminate enantiomers by using chiral Mosher's acid?	**CO 2**	**Level-1**
12	**Module 2**	Describe the ^{31}P NMR spectra of H_3PO_4 and H_3PO_3.	**CO 2**	**Level-2**
13	**Module 3**	Discuss the Retro-Diels-Alder fragmentation pattern with examples.	**CO 3**	**Level-2**
14	**Module 3**	Write about MALDI	**CO 3**	**Level-1**
15	**Module 4**	Explain the Koopman's theorem.	.CO 4	**Level-1**
16	**Module 4**	Explain the principle and selection rules of ESR	CO 4	**Level-2**

d. **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	10	2	5X4=20
2	15	2	2	10	2	
3	15	3	2	10	2	
4	15	4	2	10	2	

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CO-PO Mapping

CO	PO	Cognitive Level	Class room sessions (hrs)
1	1	Understanding	15
2	5	Evaluating	15
3	2	Problem solving	15
4	2	Application	15

SEMESTER-II PRACTICALS

CHEMISTRY LAB: DSC- 4

LAB: ANALYTICAL CHEMISTRY

Program: M.Sc.
Course: Discipline Specific Core
Semester: II

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

COURSE OBJECTIVES:

1. To estimate quantities using various titration techniques
2. To interpret various organic compounds using spectral analysis
3. 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.

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Lab course 4 **Analytical Chemistry** **4 hrs/week**

I. Spectral analysis: Interpretation of IR, UV, ^{1}H NMR and MS of the following representative compounds

1. Alcohol
2. Phenols
3. Aromatic aldehyde
4. Aromatic Ketone
5. Aromatic carboxylic acid
6. An Ester
7. An amine
8. Amide

II. Instrumental Analysis:
Conductometry:

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

Potentiometry:

10. Titration of Fe^{+2} vs $Cr_2O_7^{-2}$ (redox titration)

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

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

pH metry:

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

Colorimetry

14.Verification of Beer's law and calculation of molar extinction coefficient using CuSO4 solution.

15.Verification of Beer's law and calculation of molar extinction coefficient using KMnO4. Solution.

References Books

1.Vegel's textbook of Quantitative Inorganic Analysis, 6 edition, J. Mendham etal, Pearson education Ild (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

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ANALYTICAL CHEMISTRY
PRACTICAL MODEL PAPER

Course Code: P26/CHE/DSC/204 /P **Max Time:3Hrs**
Credits: 2 **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)** **20M**

   OR

   b) Estimate the amount of the substance using iodometry/ permanganometry/ complexometry/ acid base titration. **(CO1).**

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. Saritha Aduri**	**Prof. Uma Joseph**

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PANEL OF EXAMINERS

FACULTY OF SCIENCES - DEPARTMENT OF CHEMISTRY

CBCS-2026

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(Autonomous & Affiliated to Osmania University)

Faculty of Science – Department of Chemistry

THEORY SYLLABUS CBCS-2026

SEMESTER –II

Paper Title: Inorganic Chemistry-II

Programme: M.Sc. **Course Code: P26/CHE/DSC/201/L** **Type of course: Discipline Specific Core**	**Max. Hours: 60** **Hours per week: 4** **Max. Marks: 100** **No. of credits: 4**
Module 1: Reaction mechanism of Transition Metal Complexes	
Module 2: Bonding in metal complexes-II	
Module 3: Metal clusters	
Module 4: Bio coordination chemistry	

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THEORY SYLLABUS CBCS-2026
SEMESTER –II

Paper title: Inorganic Chemistry -II

1.Course Description

Programme: M.Sc.
Course Code: P26/CHE/DSC/201/L
Type of course: Discipline Specific Core
No. of credits: 4

Max. hours: 60
Hours per week:4
Max. marks: 100

2. Course objectives

1. To study and understand the current classification of Inorganic Reaction Mechanisms.
2. 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.
3. To understand the physical basis of the 18-electron rule and appreciate the synergic nature of bonding in metal carbonyl complexes.
4. To understand the role of metal ions in biochemistry. Their use in O_2 transport, e^- Transfer, communication, catalysis, transport, storage, will be discussed.

3. Course outcome

CO1: The study of ligand substitution mechanisms in octahedral and square planar complexes and electron transfer reactions collectively provides a comprehensive understanding of reaction mechanisms in coordination chemistry, essential for advanced research, pharmaceutical chemistry, catalysis, and materials science.

CO2: The concepts of free ion configurations, terms and states for various electronic configurations, provide a unified theoretical framework for understanding and interpreting spectroscopic transitions in atomic and coordination chemistry.

CO3: Discuss classification of clusters and different structural patterns of metal clusters.

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Explain how low nuclearity clusters differ from high nuclearity clusters and capping rule in metal clusters

CO4: Metal ions act as essential cofactors in biological systems, influencing enzyme activity, oxygen transport (Hemoglobin, Myoglobin), photosynthesis (Photosystem I, Photosystem II), and metabolic reactions such as those involving vitamin B6.

4. Course Content

Module 1: Reaction Mechanisms of Transition Metal Complexes (15 hrs)

Ligand substitution reactions
Types of substitution Reactions (SE, SN, SN^1, SN^2). Long ford and Grey classification–A mechanism,
D- Mechanism, Ia, Id and Intimate mechanism.
Ligand substitution reactions in octahedral Complexes.
Aquation or Acid hydrolysis reactions, Factors affecting Acid Hydrolysis, Base Hydrolysis, Conjugate Base Mechanism, Evidence in favour of SN^1CB Mechanism.
Substitution reactions without Breaking Metal-Ligand bond. Anation reactions
Ligand Substitution reactions in Square-Planar complexes: Mechanism of Substitution in Square-Planar Complexes-Trans-effect, Trans-influence, Grienberg's Polarization theory and Π-bonding theory– Applications of Trans-effect in synthesis of Pt (II)complexes.
Electron Transfer Reactions (or Oxidation-Reduction Reactions) in Coordination compounds: Mechanism of One-electron Transfer Reactions: Atom (or group) Transfer or Inner Sphere Mechanism, Direct electron Transfer or Outer Sphere Mechanism. Factors Affecting direct electron transfer reactions,Cross reactions and Marcus-Hush theory.

Module 2: Bonding in Metal Complexes – II 15 hrs
Free ion terms and Energy levels:Configurations,Terms,States and Microstates–Formula for the calculation of Microstatesp^nandd^nconfigurations–L-S(Russel-Saunders)coupling scheme–j-jcoupling scheme–Determination of terms for various $p^n$and d^nconfigurations of metalions.Holeformalism–Energy ordering of terms (Hund'srules) Inter–electron repulsion Parameters (Racahparameters)–Spin-Orbital coupling parameters.Effect of weak cubic crystal fields on S,P,Dand Fterms-Orgel Diagrams.

Module 3: Metal Clusters 15 hrs

Carbonyl clusters: Factors favouring Metal-Metal bonding– Classification of Clusters–
Low Nuclearity Clusters:M3 and M4 clusters, structural pattern sinM3(CO)12(M=Fe,Ru,Os) and M4(CO)12 (M=Co,Rh,Ir) Clusters. Metal carbonyl scrambling–High Nuclearity clusters

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M5,M6,M7,M8 and M10 Clusters-,Polyhedral skeletal electron pair theory and Total Electron Count theory– Capping rule – Structural patterns in $[Os6(CO)18]^{2-}$,$[Rh6(CO)16]$,$\{Os7(CO)21]$,$\{Rh7(CO)16]^{3-}$,$[Os8(CO)22]^{2-}$,$[Os10C(CO)24]^{2}$and $[Ni5(CO)12]^{2}$Metal Halide clusters: Major structural types in Dinuclear Metal Metal systems Edge sharing Bioctahedra, Face sharing Bioctahedra, Tetragonal prismatic and Trigonal antiprismatic structures, Structure and bonding in $[Re2Cl8]^{2-}$ and Octahedral halides of $[Mo6(Cl)8]^{4+}$and $[Nb6(Cl)12]^{2+}$.Trinuclearhalides of Re(III). Hoffman's Isolobal analogy and its Structural implications. Boranes, carboranes, STYX Rule. Stereochemical non-rigidity in [Rh4(CO)12] and [Fe2(Cp)2(CO)4].

Module 4: Bio- Coordination Chemistry **15 hrs**

Metal ions in biological systems: Brief survey of metal ions in biological systems.
Oxygen transport and storage: Haemoglobin (Hb) and Myoglobin (Mb) primary, secondary, tertiary and quaternary structures and non-covalent bonds present in them. Oxygenation equilibria for Mb and Hb. Factor affecting oxygenation equilibria. Cooperativity and its mechanism. Spin state of iron. Spatial and electronic aspects of dioxygen binding. Allosteric models (T and R states). Role of globin. Transport of NO andCO2. Hemocyanin (Hc) and Hemerythrin (Hr): Introduction-structure of active sites with oxygen and without oxygen. Comparison of Hemerythrin and Hemocyanin with haemoglobin.
Photosynthesis: Structural aspects of Chlorophyll. Photo system I and Photo system II.
Vitamin B_6 model systems: Forms of vitamin B_6 with structures. Reaction mechanisms of (1) Transamination (2) Decarboxylation and (3) Dealdolation in presence of metal ions.

5. Reference Books

1. Inorganic Reaction Mechanisms. M.L. Tobeand 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. Murilloand M.Bochmann,6 The Edition, Wiley Interscience, N.Y(1999
6. Inorganic Chemistry, J.E. Huheey, K.A. KeiterandR. L. Keiter 4th Edition Harper Cottens College Publications (1993).
7. Inorganic Biochemistry Edited by G.L. Eichorn, Volume 1 Elsevier (1982)
8. TheChemistryofMetalClusterComplexes.D.F. Shriver, H.D. Kaerzand R.D. ams(Eds),VCH, NY (1990).
9. Inorganic Chemistry, KeithF. Purcell and JohnC .Kotz, Holt-Saunders International

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Editions, London (1977)
10.Bioinorganic Chemistry, I.Bertini, H.B. Gray,S.J. Lippardand 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 Wileyand Sons, NY (1999).

6. 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
Global	It integrates chemistry, biology, medicine, and environmental science to support healthcare improvement, enhance agricultural sustainability, contribute to renewable energy research, and pharmaceutical innovation, and strengthen overall scientific research capacity.

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(b)Components on Skill Development/EntrepreneurshipDevelopment/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 Analysist
ED	Module 3	Metal Clusters widely used as Catalysts in Industry

(c) IKS components

IKS	Syllabus content	Module
IKS	Bioinorganic concepts can be related to traditional Indian medical knowledge in Ayurveda, which explains the role of metals and minerals in health and metabolism. These ideas may also be linked with traditional concepts of life processes described in ancient texts like the Charaka Samhita, including aspects related to respiration and plant life.	IV

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7. Pedagogy

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
4.	Peer teaching & learning	Students teach the topics assigned to their classmates

8. Course Assessment Plan

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

Max. Marks : 20 M		**Max. marks : 20 M**	
CIA - 1	**CIA - 2**	**Skill Based Test - 1(10M)**	**Skill Based Test -2 (10M)**
Section A: **1X10=10M** Essay question (Module 1) 2 questions given. Answer ONE **Section B:** **2X5=10M** Short questions (Module 2) 3 questions given. Answer TWO	**Section A:** **1X10=10M** Essay question (Module 3) 2 questions given. Answer ONE **Section B:** **2X5=10M** Short questions (Module 4) 3 questions given. Answer TWO	Discretion of the faculty	Discretion of the faculty
Average of two IA's will be considered			

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External QP Pattern		
4 Credits 4 Modules **(CORE)**	SECTION A - Internal Choice	**4 Q X 10 M = 40M**
	SECTION B – Answer any 5 out of 8 (To compulsorily have ONE question from each module)	**5 Q X 4 M = 20M**

b. Aligning COs with Continuous Internal Assessments

CO	Continuous Internal Assessments CIA– 40%	EndSemesterExamination- 60%
CO1	CIA-1- Written Exam	Written Exam
CO2	CIA -1- Written Exam	
CO3	CIA-2- Seminar /Google form	
CO4	CIA-2-Quiz/ Models	

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ABSTRACT MODEL PAPER

END SEMESTER EXAM

Paper Title -Inorganic Chemistry -II

Time: 2½hrs **Course Code:P26/CHE/DSC/201/L**

Max marks: 60

SECTION –A (Essay Questions)

I. Answer the following **4x 10=40 Marks**

1. (a)
   (b)
   OR
2 (a)
   (b)
3. (a)
   (b)
   OR
4 (a)
   (b)
5. (a)
   (b)
   OR
6 (a)
   (b)
7. (a)
   (b)
   OR
8 (a)
   (b)

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SECTION –B (Short Answer Questions)

II. Answer any five . **5 X 4 =20 Marks**

9.

10.

11.

12.

13.

14.

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16.

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

Course Code: P26/CHE/DSC/201/L **Max Marks:60**
Credits: -4 **MaxHours:2½hrs**

SECTION-A

Answer the following Questions **4 X 10 = 40 M**

1.a) Write a short note on Nucleophilic Substitution in Metal complexes (CO1) **Level 2**
b) Draw the Energy Profile diagram of SN^1&SN^2 Reaction mechanisms (CO1) **Level 2**

OR

2. a) Explain in detail about SN^1CB **Base Hydrolysis reaction** and evidences in favour of Base hydrolysis (CO1) **Level 2**
b) Explain the mechanism of the outer sphere Electron Transfer reaction with example. (CO1) **Level 2**

3. a) Define Microstates and calculate the number of Microstates in d^2 Configuration (CO2) **Level 2**
b) Explain the concept of Hole Formalism with suitable examples. (CO2) **Level 5**

OR

4. a) Write about inter-electronic repulsion and Spin-orbital coupling parameters (CO2) **Level 2**
b) Draw an Orgel diagram for ^{2}**D** energy term in Octahedral and Tetrahedral Environment (CO2) **Level 2**

5. a) Write an account on Polyhedral Skeletal Electron pair theory and explain the Structural pattern in [Rh6(CO)16 (CO3) **Level 1**

b) Give the structural Pattern in M4(CO)12 with M=Co, Rh, Ir) (CO3) **Level 2**

OR

6. a) Explain the Structure and Bonding in $[Re2Cl8]^{-2}$ (CO3) **Level 2**
b) Give an account on Metal Halide Clusters (CO3) **Level 2**

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7. (a) Draw allosteric models of Heamoglobin and explain the role of Globin chains. (CO4) **Level 1**
   (b) Explain the structural aspects of Chlorophyll. (CO4). **Level 2**

OR

8. (a) Write a note on transportation of NO and CO2. (CO4) **Level 2**
   (b) Draw a step-by-step electron flow in Z- Scheme of Photosynthesis (CO4). **Level 3**

SECTION -B

Answer any five questions **(5X 4=20 M)**

9. Write a Short Note on Trans Effect and its Applications. (CO1) **Level 2**
10. Explain the Inner sphere mechanism with an example. (CO1) **Level 3**
11. List Hund's rules to explain the energy ordering of terms with examples. (CO2) **Level 4**
12. Draw the Orgel diagram for ^4F Energy Term for Octahedral Geometry. (CO2) **Level 1**
13. What is the STYX Rule, explain with an example. (CO3) **Level 2**
14. Explain Hoffman's Isolobal analogy with suitable examples (CO3) **Level 2**
15. Write the mechanism of Decarboxylation catalyzed by Vitamin B6. (CO4) **Level 2**
16. Discuss the role played by bulk metal ions Na+ and K+ in biological systems. (CO4). **Level 3**

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(An Autonomous College Affiliated to Osmania University)
Faculty of Science – Department of Chemistry
MODEL PAPER
M.Sc. I YEAR SEMESTER -II
INORGANIC CHEMISTRY - II

Time: 2½hrs **Course Code: P26/CHE/DSC/201/L**

Max. Marks: 60

SECTION A - INTERNAL CHOICE				**4 X 10 = 40 M**
Question Number	**Module**	**Question**	**CO**	**BTL**
1	**I**	a) Write a short note on Nucleophilic Substitution in Metal complexes b) Draw the Energy Profile diagram of SN^1&SN^2 Reaction mechanisms Symmetry on BF3. **OR**	**CO1**	**Level 2**
2	**I**	a) Explain in detail about SN^1CB **Base Hydrolysis reaction** and evidences in favor of Base hydrolysis b) Explain the mechanism of the outer sphere Electron Transfer reaction with example	**CO1**	**Level 2**
3	**II**	a) Define Microstates and calculate the number of Microstates in d^2 Configuration b) Explain the concept of Hole Formalism with suitable examples.	**CO2**	**Level 2 & 5**

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4	II	a) Write about inter-electronic repulsion and Spin-orbital coupling parameters. b) Draw an Orgel diagram for ^2D energy term in Octahedral and Tetrahedral Environment	CO2	Level 2
5	III	(a) Write an account on Polyhedral Skeletal Electron pair theory and explain the Structural pattern in [Rh6(CO)16 b) Give the structural Pattern in M4(CO)12 with M=Co, Rh, Ir)	CO3	Level 1&2
6	III	a) Explain the Structure and Bonding in $[Re2Cl8]^{-2}$ b) Give an account on Metal Halide Clusters	CO3	Level 2
7	IV	(a) Draw allosteric models of Heamoglobin and explain the role of Globin chains. (b) Explain the structural aspects of Chlorophyll.	CO4	Level 1& 2
8	IV	(a) Write a note on transportation of NO and CO2.(CO4) (b) Draw a step by step electron flow in Z- Scheme of Photosynthesis (CO4).	CO4	Level 2 & 3
SECTION B - Short answer questions **ANSWER ANY 5 OUT OF 8**				**5 X 4 = 20M**
9	I	Write a Short Note on Trans Effect and its Applications.	CO1	Level 2
10	II	Explain the Inner sphere mechanism with an example.	CO1	Level 3

11	**II**	List Hund's rules to explain the energy ordering of terms with examples.	**CO2**	**Level 4**
12	**III**	Draw the Orgel diagram for ^4F Energy Term for Octahedral Geometry.	**CO2**	**Level 1**
13	**III**	What is the STYX Rule, explain with an example.	**CO3**	**Level 2**
14	**IV**	Explain Hoffman's Isolobal analogy with suitable examples.	**CO3**	**Level 2**
15	**V**	Write the mechanism of Decarboxylation catalyzed by Vitamin B6.	**CO4**	**Level 2**
16	**VI**	Discuss the role played by bulk metal ions Na+ and K+ in biological systems.	**CO4**	**Level 3**

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	5X4=20
2	15	2	2	12	2	
3	15	3	2	12	2	
4	15	4	2	10	2	

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9.CO-PO Mapping

CO	PO	Cognitive Level	Class room sessions(hrs)
1	2	Applying	15Hrs
2	3	Understanding	15Hrs
3	3	Understanding	15Hrs
4.	1	Understanding	15 Hrs

SEMESTER-II PRACTICALS

CHEMISTRY LAB **LAB: INORGANIC CHEMISTRY**

Program: M.Sc.
Course: Discipline Specific Core
Semester: II

Subject Code P26/CHE/DSC/201/P
No. of Hrs. allotted: 4 Hrs / week
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.

Practicals Inorganic Chemistry Lab course

1. **Preparation of complexes:**
   Mercury Tetra Thio cyanate Cobaltate (II).
   Chloropentammine Cobalt (III) chloride
   Tetrammine copper (11) sulphate

2. **Titrimetric Analysis of two ions in a mixture**
   Estimation of Pb^{2+} and Ca^{2+}
   Estimation of Zn^{2+} and Mg^{2+}
   Estimation of Mg^{2+} and Mn^{2+}

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3.**Analysis of Two component mixtures**

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

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

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

4.**Analysis of three component mixtures**

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

5.Ion exchange methods of analysis

Determination of capacity of an ion exchange resin.

Separation of Mg2+ and Zn2+on an anion exchange resin and estimation of Zn2+ 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 etal, 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)

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INORGANIC CHEMISTRY PRACTICAL MODEL PAPER

Course Code: P26/CHE/DSC/201/P
Credits: 2

Max Time: 3hrs
Max marks :50

Answer all questions

Explain the principle and procedure for the Synthesis of the metal complex (CO1) 10 M

OR

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)

Separate the metal ions in the given mixture solution and estimate Metal ion by Gravimetric method and -------- metal by Volumetric method. (CO2) (25M)

Record and Attendance (5M)

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**
Madhuri	B. Saritha Head Department of Chemistry St. Francis College for Women Begumpet, Hyderbad-16.	
Dr Y. Lakshmi Madhuri	**Dr Saritha Aduri**	**Prof. Uma Joseph**

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Faculty of Science – Department of Chemistry

THEORY SYLLABUS CBCS-2026

SEMESTER –II

Paper Title: Organic Chemistry-II

Programme: M. Sc. **Course Code: P26/CHE/DSC/202/L** **Type of course: Discipline Specific Core**	**Max. Hours: 60** **Hours per week: 4** **Max. Marks: 100** **No. of credits: 4**
Module 1: Pericyclic reactions	
Module 2: Photochemistry	
Module 3: Molecular Rearrangements	
Module 4: Heterocyclic compounds & Natural products	

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SEMESTER –II

ORGANIC CHEMISTRY-II

THEORY

1. Course Description

Programme: M.Sc. **Max. Hours: 60**

Course Code: P26/CHE/DSC/102/L **Hours per week:4**

Type of course: Discipline Specific Core **Max. Marks: 100**

2. Course objectives

1. Pericyclic reaction is a type of organic reaction where in the transition state of the molecule has a cyclic geometry and the reaction progresses in a concerted fashion. And also deals with the Aromaticity of organic compounds.
2. The study is aimed at learning photochemical organic reactions and mechanisms like electrocyclic, radical, photo isomerization and Norrish reactions.
3. Involvement of reactive intermediates in various rearrangements.
4. To rationalize on the nomenclature, synthesis and reactivity of some heterocyclic compounds and structure determination of simple natural products.

3. Course outcomes

CO1: Selection rules for pericyclic reactions like Electrocyclic reactions, Cycloaddition reactions and Sigmatropic reactions by various methods.

CO2: Discuss the organic Photochemical reactions with their mechanism.

CO3: Reactive intermediates formation during molecular rearrangements.

CO4: Explain the nomenclature, synthesis and reactivity of heterocyclic compounds and study of general methods in structure determination of terpenoids and alkaloids.

Expected Level of Output: Conceptual level

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4. Course Content

Module 1: 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 antara facial additions in 4n and4n+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.

Module2: Photochemistry **15hrs**

Photochemistry: Photochemistry of π-π* transitions: Excited states of alkenes, cis-trans isomerisation, and photo stationary state. Photochemistry of di-π methane rearrangement. Intermolecular reactions, photocycloadditions, Photodimeriastion of simple olefins. Addition of olefins to α, β-unsaturated carbonyl compounds. Excited states of aromatic compounds, Photoisimerisation 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.

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.

IKS Component: Photochemistry of π → π* Transitions

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Module 3: Molecular rearrangements **15 hrs**

Molecular rearrangements: Definition and classification. Molecular rearrangements involving

1) Electron deficient carbon: Wagner- Meerwein, Pinacol-Pinacolone, Allylic and Wolf rearrangement.

2) Electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt and Beckmann rearrangements

3) Electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalysed rearrangements: Benzilic acid, Favourski, Transannular, Sommlett-Hauser and Smiles rearrangement.

Module 4: Heterocyclic compounds & Natural products **15 hrs**

Heterocyclic compounds: Introduction, Nomenclature Synthesis and reactivity of indole, quinoline, isoquinoline, carbazole and acridine

Natural products: Importance of natural products as drugs.

Terpenoids: Isoprene rule. Structure determination and synthesis of β-carotene, α-terpeniol and camphor.

Alkaloids: Structure determination and synthesis of papaverine.

IKS Component: Heterocyclic compounds and Natural Products

5. References books

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. Organic chemistry Vol.I and II by I.L.Finar
9. Comprehensive organic chemistry Vol.5 D.H.R.Barton and W.D..Ollis
10. Heterocyclic Chemistry, T.L. Gilchrist, Longman UK Ltd, London (1985).
11. Benzofurans A. Mustafa, Wiley-Interscience,New York (1974).
12. Heterocyclic Chemistry, 3rdEdnJ.A.Joule, K.Mills and G.F.Smith, Stanley Thornes Ltd, UK, (1998)
13. The Chemistry of Indole, R.J.Sunderberg, Academic Press, New York (1970).
14. An introduction to the chemistry of heterocyclic compounds, 2nd Edn. R.M.Acheson, Interscience Publishers, New York, 1967.

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6. Syllabus Focus

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

Local /Regional/National /Global Development Needs	Relevance
Local	Rearrangements strengthen conceptual understanding. Support pharmaceutical and textile industries. Aid in drug and polymer synthesis. Play a key role in academic and competitive exams.
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	Heterocyclic compounds are backbone of many antibiotics, antifungals, anticancer, and antiviral drugs. Supports India's pharmaceutical industry, which is one of the largest globally. Natural products support India's pharmaceutical industry (generic and herbal drugs). Provides affordable medicines domestically and globally. Strengthens traditional systems like Ayurveda.
Global	Numerous life processes depend heavily on pericyclic reactions. For instance, prephenate is produced when chorismate experiences a cycloaddition reaction in Escherichia coli. The epidermis undergoes a [1,7]-sigmatropic process to produce vitamin D.

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b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
ED	Module- III	Establish a small-scale unit manufacturing pharmaceutical intermediates using rearrangement chemistry.
EMP (NSQF Level 4,5,6 & 7)	Module- II	Design and implement practical laboratory experiments that allow students to apply photochemical principles.
SD	Module- I	Solving theoretical problems and interpreting results
EMP (NSQF Level 4,5,6 & 7)	Module- IV	Strong demand in pharmaceutical and agrochemical sectors. Essential in R&D and innovation. Natural products provides employment in herbal drug manufacturing and export industries.

c) IKS components

IKS	Syllabus Content	Module
IKS	Photochemistry of $\pi \rightarrow \pi^*$ Transitions Heterocyclic compounds and Natural Products	II & IV

d. Aligned with SDG 3 Good Health and Well-Being4 (Quality Education), SDG 9 – Industry, Innovation and Infrastructure, SDG 12 – Responsible Consumption and Production, SDG 7 – Affordable and Clean Energy, SDG 2 – Zero Hunger

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7. 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
4.	Peer Teaching	Students work in small groups to discuss about the topics and solve the problems related to subject

8. Course Assessment Plan

a. Weightage of Marks in Continuous Internal Assessments andEnd Semester Examination

Maximum Marks: 20M		**Maximum Marks: 20M**	
CIA 1 **Subjective**	**CIA 1** **Subjective**	**CIA 2** **Skill Based Test: 10M**	**CIA 2** **Assignment: 10M**
Section A: 1x10=10M Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	**Section A: 1x10=10M** Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	Discretion of the faculty	Discretion of the faculty

External QP Pattern		
4 Credits 4 Modules (CORE)	SECTION A - Internal Choice	**4 Q X 10 M = 40M**
	SECTION B – Answer any 5 out of 8 (To compulsorily have ONE question from each module)	**5 Q X 4 M = 20M**

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b) Aligning COs with Continuous Internal Assessments

Cos	Continuous Internal Assessments - CIA (40%)	End Semester Examination - (60%)
CO1	CIA-1	End Semester examination
CO2	CIA-1	
CO3	CIA-2 Presentation	
CO4	CIA-2 Assignment	

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c. Question Paper Pattern:

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ABSTRACT MODEL PAPER

END SEMESTER EXAM

Paper Title -Organic Chemistry -II

Time: 2½hrs **Course Code:P26/CHE/DSC/202/L**

Max marks: 60

SECTION – A

Answer all questions **(4X10=40 M)**

1. (a).
   (b).

(or)

2. (a).
   (b)

3. (a).
   (b).

(or)

4. (a).
   (b).

5. (a).
   (b).

(or)

6. (a).
   (b).

7. (a).
   (b).

(or)

8. (a).
   (b).

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SECTION - B

Answer any 5 of the following questions **(5X4 =20 M)**

9.
10.
11.
12.
13.
14.
15.
16.

b) Model Question Paper- End Semester Exam

ORGANIC CHEMISTRY-II

MODEL QUESTION PAPER

THEORY

Course Code: P24/CHE/DSC/202/L **Max Marks:60**

Credits: 4 **MaxHours:2½hrs**

SECTION A

I Answer the following Questions **4 x 10 = 40 M**

1. a) List the selection rules for 4n+2 sigmatropic reactions by ATS approach **(CO1) (Level-1)**

   b) Describe Claisen rearrangement with examples. **(CO1) (Level-2)**

OR

2. a) Write all the molecular orbitals of 1,3,5 Hexatriene, indicate their Frontier Molecular Orbitals in ground state and First Excited state **(CO1) (Level-1)**

   b) Write all the selection rules for cycloaddition reactions? Explain them by FMO method **(CO1) (Level-1)**

3. a) Write about Norrish Type -II reaction **(CO2) (Level-1)**

   b) Write a note on di-π methane rearrangement. **(CO2) (Level-1)**

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4. a) Illustrate Norrish type 1 cleavage process **(CO2) (Level-2)**

   b) Explain the Photoisomerisation of benzene. **(CO2) (Level-2)**

5. Outline the mechanism of following rearrangements **(CO3) (Level-2)**

   i) Baeyer -Villiger rearrangement

   ii) Benzilic acid rearrangement

OR

6. Describe the mechanism of following rearrangements **(CO3) (Level-2)**

   i) Beckmann Rearrangement

   ii) Smiles Rearrangement

7. a) Write any two synthetic methods of Indole **(CO4) (Level-1)**

   b) Write the synthesis of β-carotene **(CO4) (Level-1)**

OR

8. a) Elucidate the structure of Camphor **(CO4) (Level-2)**

   b) Explain the reactivity of Quinoline**(CO4) (Level-2)**

SECTION-B

II Answer any FOUR **5 x4 = 20 M**

9. Write all the molecular orbitals of allyl system. Indicate HOMO and LUMO under Ground state and First Excited state. **(CO1) (Level-1)**

10. List the selection rules of electrocyclic reactions based on PMO approach. **(CO1) (Level-1)**

11. What is Barton reaction? Explain its mechanism. **(CO2) (Level-1)**

12. Outline the mechanism of PaternoBuchi reaction. **(CO2) (Level-2)**

13. Outline the mechanism of Sommlett-Hauser rearrangement **(CO3) (Level-2)**

14. Write a note on Curtius rearrangement **(CO3) (Level-1)**

15. What is Isoprene rule explain with examples**(CO4) (Level-1)**

16. Explain the reactivity of Carbazole. **(CO4) (Level-2)**

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SECTION A - INTERNAL CHOICE		4Q X 10 M = 40 M		
Question Number	**Module**	**Question**	**CO**	**BTL**
1	**Module 1**	a) List the selection rules for 4n+2 sigmatropic reactions by ATS approach b) Describe Claisen rearrangement with examples. OR	**CO 1**	**Level I** **Level II**
2	**Module 1**	a) Write all the molecular orbitals of 1,3,5 Hexatriene, indicate their Frontier Molecular Orbitals in ground state and First Excited state. b) Write all the selection rules for cycloaddition reactions? Explain them by FMO method.	**CO 1**	**Level I** **Level I**
3	**Module 2**	a) Write about Norrish Type -II reaction. b) Write a note on di-π methane rearrangement. OR	**CO 2**	**Level I** **Level I**
4	**Module 2**	a) Illustrate Norrish type 1 cleavage process b) Explain the Photoisomerisation of benzene.	**CO 2**	**Level II** **Level II**
5	**Module 3**	Outline the mechanism of following rearrangements i) Baeyer -Villiger rearrangement ii) Benzylic acid rearrangement OR	**CO 3**	**Level II**

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6	**Module 3**	Describe the mechanism of following rearrangements i) Beckmann Rearrangement ii) Smiles Rearrangement	**CO 3**	**Level II**
7	**Module 4**	i) Write any two synthetic methods of Indole ii) Write the synthesis of β-carotene OR	**CO4**	**Level I** **Level I**
8	**Module 4**	a) Elucidate the structure of Camphor b) Explain the reactivity of Quinoline	**CO4**	**Level-II** **Level-II**

SECTION B - ANSWER ANY 5 OUT OF 8 **5 Q X 4M = 20 M**

(To compulsorily have Two questions from each module)

9	**Module 1**	Write all the molecular orbitals of allyl system. Indicate HOMO and LUMO under ground state and First Excited state.	**CO 1**	**Level I**
10	**Module 1**	List the selection rules of electrocyclic reactions based on PMO approach.	**CO 1**	**Level I**
11	**Module 2**	What is Barton reaction? Explain its mechanism.	**CO2**	**Level I**
12	**Module 2**	Outline the mechanism of PaternoBuchi reaction.	**CO 2**	**Level II**
13	**Module 3**	Outline the mechanism of Sommlett-Hauser rearrangement	**CO 3**	**Level II**
14	**Module 3**	Write a note on Curtius rearrangement	**CO3**	**Level I**
15	**Module 4**	What is Isoprene rule explain with examples	**CO4**	**Level-1I**
16	**Module 4**	Explain the reactivity of Carbazole.	**CO4**	**Level-1I**

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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	10	2	5X4=20
2.	15	2	2	10	2	
3.	15	3	2	10	2	
4.	14	4	2	10	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
4	6	Understanding	15

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PRACTICAL SYLLABUS CBCS-2026

SEMESTER -II

ORGANIC CHEMISTRY

Course Code: P24/CHE/DSC/202/P **Max. Marks: 50**

Course: Discipline Specific Core **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, (Lassagnine 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, βGlucose, benzoic acid, 2-chloro benzoic Acid, Anisic acid, p-Nitrobenzoic acid; p-Cresol, p-Chlorophenol,

REFERENCE BOOKS

1. Text book of practical organic chemistry, Vogel
2. Text book of practical organic chemistry, Mann and Saunders.
3. Spectral identification of organic compounds Bassler, Silverstein 5th Edition.

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SEMESTER II

ORGANIC CHEMISTRY-II

MODEL PRACTICAL QUESTION PAPER

Course Code: P20/CHE/DSC/202/P **Time: 3Hrs**

Credits: 2 **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/ Programme Coordinator [Name &Signature]	Approved by the Principal
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Faculty of Science – Department of Chemistry

THEORY SYLLABUS CBCS-2026

SEMESTER – II

Paper Title: Physical Chemistry-II

Programme: M.Sc. Organic Chemistry **Course Code: P26/CHE/DSC/203/L** **Type of course: Discipline Specific Core**	**Max. Hours: 60** **Hours per week: 4** **Max. Marks: 100** **No. of credits: 4**
Module 1: Thermodynamics - II	
Module 2: Chemical Kinetics	
Module 3: Photochemistry	
Module 4: Quantum Chemistry-II	

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SEMESTER –II

PHYSICAL CHEMISTRY-II

THEORY

1. Course Description

Programme: M.Sc.
Course Code: P26/CHE/DSC/203/L
Type of course: Discipline Specific Core
No. of credits: 4

Max. Hours : 60
Hours per week:4
Max. Marks: 100

2. Course objectives:

1. To explore the thermodynamics of real solutions, non-ideal systems, and multicomponent phase equilibria.
2. To provide a rigorous mathematical treatment of reaction rates, transition states, and structural effects on reactivity.
3. To analyze the physical and chemical processes occurring in electronically excited states, focusing on radiative and non-radiative transitions.
4. To extend quantum mechanical principles to multi-electron systems, including the Hydrogen atom and approximate methods.

3. Course Outcomes:

CO1: Students will be able to calculate partial molar properties and determine the fugacity and activity coefficients of non-ideal solutes.
CO2: Students will be able to derive the Eyring equation to interpret activation parameters and apply Hammett and Taft equations to predict substituent effects on reaction mechanisms.
CO3: Students will be able to construct Jablonski diagrams to explain fluorescence and phosphorescence and apply the Stern-Volmer equation to quantify quenching kinetics.
CO4: Students will be able to apply approximate methods like Variation method to solve the Schrödinger equation for many-electron systems

Expected Level of Output: Conceptual level

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4. Course Content

Module 1 -Thermodynamics-II **(15 Hrs)**

Solutions: Specifying the composition. Partial molar properties and their significance. Relation between solution volume and partial molar volume. Measurement of partial molar volumes—slope and intercept methods. The chemical potential: Variation of chemical potential with T and P. Gibbs-Duhem equation—derivation and significance.

Ideal Solutions: Thermodynamic properties of ideal solutions. Thermodynamics of mixing (ΔG_{mix}, ΔH_{mix}, ΔS_{mix}, ΔV_{mix},). Vapour pressure - Raoult's law. Thermodynamic properties of ideally dilute solutions. Vapour pressure - Henry's law.

Non-Ideal Systems:

Concept of fugacity and fugacity coefficient (qualitative). Determination of fugacity.

Non-Ideal Solutions: Activities and activity coefficients. Standard-state conventions for non-ideal solutions. Excess functions—definition, significance, typical forms (G^E, H^E, S^E, V^E). Determination of activity coefficients from vapor pressure measurements. Activity coefficients of nonvolatile solutes using Gibbs-Duhem equation.

Multicomponent Phase Equilibria (Colligative Properties): Vapor pressure lowering, freezing point depression, and boiling point elevation. Derivation of colligative properties with molar mass of solute and their applications. Numerical problems.

Module 2 - Chemical Kinetics **(15 Hrs)**

Theories of reaction rates: Collision theory, steric factor, transition state theory, reaction coordinate, activated complex and the transition state. Thermodynamic formulation of transition state theory- Derivation of Eyring equation and interpretation of activation parameters and their significance.

Unimolecular reactions and Complex reactions: Unimolecular reactions - Lindemann's theory, Complex reactions (all first-order type) — Opposing reactions, parallel reactions and consecutive reactions, 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 equation: substituent constant (σ) and reaction constant (ρ); applications and limitations. Taft equation: substituent constant (σ^*) and reaction constant (ρ^*); Taft four-parameter equation. Numerical problems on Hammett and Taft equations.

Deviations from Hammett correlations: Change of mechanism, resonance effects. Correlations for nucleophilic substitution reactions: Swain-Scott equation, Edwards equation. Examples from nucleophilic substitution reactions.

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Kinetics in Solutions: Primary and secondary salt effects. Marcus theory of electron transfer reactions (qualitative discussion with free energy diagrams)—Hammond's postulate (qualitative).

Module 3 - Photochemistry (15 Hrs)

Molecular Electronic Transitions: Electronic transitions in molecules, Franck-Condon principle. Singlet and triplet states, formation of excimers and exciplexes. Energy diagrams. Radiative and non-radiative lifetimes of excited states—theoretical treatment. Measured lifetimes.

Quantum Yield and Measurement: Definition and determination of quantum yields. Actinometry—ferrioxalate and uranyl oxalate actinometers (with problems). Derivation of fluorescence and phosphorescence quantum yields. E-type and P-type delayed fluorescence—evaluation of triplet energy splitting (ΔE_{ST}).

Photophysical Processes and Kinetics: Photophysical kinetics of unimolecular reactions. Rate constants of various photophysical processes—problems. Energy level/State diagrams.

Photochemistry (General Aspects): Primary photochemical processes. Effect of light intensity on reaction rates. Photosensitization and Quenching—Stern-Volmer equation.

Fast Reactions: Introduction to fast reactions. Principle and applications of flash photolysis.

Module 4: Quantum Chemistry- II (15 Hrs)

Hydrogen atom and Atomic orbitals: Coordinate systems: Cartesian, Polar and spherical polar coordinates, and 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* — meaning and importance. Radial distribution functions. Representation of Hydrogenic orbitals: Polar plots, contour plots and boundary diagrams.

Approximate methods for many electron systems: The variation method—variation theorem and its proof. Trial variation functions and variation integrals, examples of variational calculations for simple systems. Particle in a box revisited: construction of trial function by the method of linear combinations, variation parameters. Secular equations and secular determinants.

Bonding in molecules: Molecular orbital theory—basic ideas. LCAO construction of MOs - H_2^+ ion. Variation integral for H_2^+ ion. Detailed calculation of Wave functions and energies for the bonding and antibonding MOs—physical interpretation. The MO wave function and energies and

energy diagram of H_2 molecule. Comparison of MO by LCAO method and Valence bond method models (detailed calculations not required).

5. Reference Books:

1. Physical Chemistry—A Molecular Approach, D.A. McQuarrie and J.D. Simon, Viva Books Pvt Ltd. 2011/2020.
2. Atkin's Physical Chemistry, 11e., Peter Atkins and Julio de Paula, Oxford University Press, 2018 (also 2012).
3. Fundamentals of Photochemistry, 4e, K.K. Rohtagi-Mukherji, Wiley-Eastern 2021.
4. Molecular Reactions and Photochemistry, Depuy and Chapman, Prentice Hall, 1972.
5. Molecular Photochemistry, N.J. Turro, Benjamin Publication, 2010.
6. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
7. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Wiley-Blackwell Scientific Publications, 1990.
8. Organic Photochemistry, 2e, J.M. Coxon and B. Halton, Cambridge University Press, 2011.
9. Introductory Photochemistry, A. Cox and T.J. Kemp, McGraw-Hill, London, 1971.
10. Chemical Kinetics and Reaction Mechanisms, 2e, J. H. Espenson, McGraw Hill, 1995.
11. Chemical Kinetics, 3e, K.J. Laidler, McGraw Hill, 2003.
12. The Physical Basis of Org. Chemistry, Howard Maskill, Oxford Univ. Press, 1985.
13. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman& J. Kuriacose, McMillan.
14. Physical Chemistry, 6e, Ira N. Levine, McGraw Hill Education, 2011.
15. Molecular Thermodynamics, D.A. McQuarrie and J.D. Simon, University Science Books, 1999.
16. Principles of Physical Chemistry, 4e, Samuel H. Maron and Carl F. Prutton, Oxford & IBH, 2017.
17. Physical Organic Chemistry, 2e, N. S. Isaacs, ELBS, 1995.
18. Elementary Quantum Chemistry, 2e, F. L. Pilar, McGraw Hill, 1990.
19. Quantum Chemistry, D.A. McQuarrie, Viva Publication, 2020.
20. Quantum Chemistry, 7e, Ira N. Levine, Prentice Hall, 2013.
21. Introduction to Quantum Chemistry, 4e, A.K. Chandra, Tata McGraw Hill, 2017.
22. Quantum Chemistry, 6e, R K Prasad, New Age International Pvt Ltd Publishers, 2024

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6. Syllabus Focus

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

Local /Regional/National /Global Development Needs	Relevance
Local	Applying Chemical Kinetics to improve local industrial reaction rates and Thermodynamics to manage the efficiency of local heating and cooling systems..
Regional	Utilizing Photochemistry for regional solar energy research and Quantum Chemistry to drive molecular modeling for regional pharmaceutical R&D hubs.
National	Using Kinetics and Thermodynamics to formulate national safety standards for chemical storage and leveraging Photochemical sensors to foster innovation in national diagnostic healthcare.
Global	Leading global efforts in green energy through advanced photochemistry and developing sustainable industrial strategies using the broad implications of Quantum molecular design.

b. Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
SD	Module 4	Constructing polar and contour plots of hydrogenic orbitals to visualize 3D electron density.
ED	Module 3	Designing chemical actinometers and exploring the commercial potential of photosensitizers in solar energy.
EMP (NSQF Level 4,5,6 & 7)	Module 1	Using slope-intercept methods to determine partial molar properties for industrial chemical formulations.
SD/EMP	Module 2	Applying Hammett/Taft equations and Marcus theory to predict reaction pathways in pharmaceutical research.

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c. IKS Components

IKS	Syllabus Content	Module
IKS	Study of activity coefficients and non-ideal solutions	1 & 2
IKS	Electronic transitions and quantum yields	3

d. Aligned with SDG 3 (Good Health and well- being), SDG 4 (Quality Education), SDG 9 (Industry, Innovation & Infrastructure), and SDG 13 (Climate Action).

7. Pedagogy

S. No	Student Centric Methods Adopted	Type / Description of Activity
1.	Experiential Learning	Simulating flash photolysis to detect short-lived intermediates.
2.	Participative Learning	Debating reaction mechanisms using Hammett plots to analyze reaction failures.
3.	Problem Solving	Modeling Excess Functions using real-world binary mixture vapor pressure data.
4.	Peer teaching	Designing infographics on Radial Distribution Functions for peer instruction.

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8. Course Assessment Plan

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

Maximum Marks: 20M		**Maximum Marks: 20M**	
CIA 1 **Subjective**	**CIA 1** **Subjective**	**CIA 2** **Skill Based Test: 10M**	**CIA 2** **Assignment: 10M**
SectionA: 1x10=10M Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	**Section A: 1x10=10M** Essay question: Answer any 1 out of 2 **Section B: 2x5=10M** Short questions: Answer any 2 out of 3	Discretion of the faculty	Discretion of the faculty

External QP Pattern		
4 Credits 4 Modules **(CORE)**	SECTION A - Internal Choice	**4 Q X 10 M = 40M**
	SECTION B – Answer any 5 out of 8 (To compulsorily have ONE question from each module)	**5 Q X 4 M = 20M**

b. Aligning COs with Continuous Internal Assessments

CO	Continuous Internal Assessments CIA – 40%	End Semester Examination-60%
CO1	CIA-1 - Written Exam	Written Exam
CO2	CIA-1 - Written Exam	
CO3	CIA-2 - Presentations	
CO4	CIA-2 - Assignment	

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c. Question Paper Pattern:

St. Francis College for Women, Begumpet

Faculty of Science – Department of Chemistry

ABSTRACT MODEL PAPER

END SEMESTER EXAM

Paper Title -Physical Chemistry - II

TIME: 2½hrs **Course Code:P26/CHE/DSC/203/L**

MAX. MARKS: 60

SECTION –A (Essay Questions)

I. Answer the following **4x 10=40 Marks**

1. (a)

(b)

OR

2. (a)

(b)

3. (a)

(b)

OR

4 (a)

(b)

5. (a)

(b)

OR

6. (a)

(b)

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7. (a)

(b)

OR

8 (a)

(b)

SECTION –B (Short Answer Questions)

II. Answer any 5 out of 8 questions **5x4=20 Marks**

9.

10.

11.

12.

13.

14.

15.

16.

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Model Question Paper - End Semester Exam

PHYSICAL CHEMISTRY-II

MODEL QUESTION PAPER

Course Code: P26/CHE/DSC/203/L **Max Marks:**60
Credits: - 4 **Max Hours:**2½hrs

SECTION-A

I Answer the following Questions **4x10= 40M**

1. (a) What is multicomponent phase equilibrium? Explain depression in freezing point.

(CO1) (Level 2)

(b) How does the chemical potential vary with T and P? **(CO1) (Level 2)**

OR

2. (a) Obtain the Standard-state conventions for non-ideal solutions. **(CO1) (Level 2)**

(b) Write short notes on Raoult's law and Henry's law. **(CO1) (Level 1)**

3. (a) Derive Eyring's equation based on transition state theory and explain the significance of $\Delta S^{\#}$. **(CO2) (Level 2)**

(b) Explain Taft four parameter equation. **(CO2) (Level2)**

OR

4.(a) Explain Lindemann's theory of unimolecular reactions **(CO2) (Level 2)**

(b)Write the Swain-Scott equation and explain the terms involved **(CO2) (Level 2)**

5. (a) Derive an expression for quantum yield of phosphorescence process. **(CO3) (Level 2)**

(b) What is Quenching? Derive Stern-Volmer equation. **(CO3) (Level 2)**

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6. (a) What is an Actinometer? Explain ferrioxalate and Uranyl oxalate actinometer. **(CO3) (Level 2)**

(b) Explain about photo abstraction and photo isomerization reactions.**(CO3) (Level 2)**

7. (a) Write the Schrodinger wave equation for the hydrogen atom and separate it into three equations **(CO4) (Level 3)**

(b) State and explain variation theorem. **(CO4) (Level 2)**

OR

8. (a) Explain secular equations and secular determinants. **(CO4) (Level 2)**

(b) Explain Radial and angular functions of hydrogen like orbitals **(CO4) (Level 2)**

SECTION-B

II. Answer any 5 out of 8 questions **5x4=20M**

9. Derive the Gibbs-Duhem equation. **(CO1) (Level 2)**
10. What are partial molar properties? Explain their significance. **(CO1) (Level 2)**
11. State and explain Hammett's relationship with examples. **(CO2) (Level 1)**
12. Discuss the primary and secondary salts effects. **(CO2) (Level 2)**
13. Explain E-type delayed fluorescence. **(CO3) (Level 1)**
14. Write about the significance of the Franck-Condon Principle.**(CO3) (Level 1)**
15. Compare Molecular Orbital theory and Valence Bond theory**(CO4) (Level 2)**
16. .Draw the polar and contour plots for hydrogen atoms.**(CO4) (Level 2)**

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SECTION A - INTERNAL CHOICE		4 Q X 10M = 40 M		
Question Number	**Module**	**Question**	**CO**	**BTL**
1	Module 1	(a) What is multicomponent phase equilibrium? Explain depression in freezing point. (b) How does the chemical potential vary with T and P? OR	CO 1	Level 2
2	Module 1	(a)Obtain the Standard-state conventions for non-ideal solutions. (b)Write short notes on Raoult's law and Henry's law.	CO 1	Level 2 &1
3	Module 2	(a)Derive Eyring's equation based on transition state theory and explain the significance of $\Delta S^{\#}$. (b)Explain Taft four parameter equation. OR	CO 2	Level 2
4	Module 2	(a)Explain Lindemann's theory of unimolecular reactions (b)Write the Swain-Scott equation and explain the terms involved	CO 2	Level 2
5	Module 3	(a) Derive an expression for quantum yield of phosphorescence process. (b) What is Quenching? Derive Stern-Volmer equation. OR	CO 3	Level 2
6	Module 3	(a)What is an Actinometer? Explain ferrioxalate and Uranyl oxalate actinometer. (b)Explain about photo abstraction and photo isomerization reactions.	CO 3	Level 2
7	Module 4	(a)Write the Schrodinger wave equation for the hydrogen atom and separate it into three equations. (b)State and explain variation theorem. OR	CO 4	Level 3 &2

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8	**Module 4**	(a)Explain secular equations and secular determinants. (b)Explain Radial and angular functions of hydrogen like orbitals.	**CO 4**	**Level 2**
SECTION B - ANSWER ANY 5 OUT OF 8 (To compulsorily have Two questions from **each** module)		**5Q X 4 M = 20 M**		
9	**Module 1**	Derive the Gibbs-Duhem equation.	**CO 1**	**Level 2**
10	**Module 1**	What are partial molar properties? Explain their significance.	**CO 1**	**Level 2**
11	**Module 2**	State and explain Hammett's relationship with examples.	**CO 2**	**Level 1**
12	**Module 2**	Discuss the primary and secondary salts effects.	**CO 2**	**Level 2**
13	**Module 3**	Explain E-type delayed fluorescence.	**CO 3**	**Level 1**
14	**Module 3**	Write about the significance of the Franck-Condon Principle.	**CO 3**	**Level 1**
15	**Module 4**	Compare Molecular Orbital theory and Valence Bond theory	**CO4**	**Level 2**
16	**Module 4**	Draw the polar and contour plots for hydrogen atoms.	**CO4**	**Level 2**

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d. 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	10	2	5x4=20
2	15	2	2	10	2	
3	15	3	2	10	2	
4	15	4	2	10	2	

9. CO-PO Mapping

CO	PO	Cognitive Level	Class room sessions(hrs)
1	2	Understand	15
2	1	Understand	15
3	6	Apply	15
4	7	Apply	15

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SEMESTER-II PRACTICALS

CHEMISTRY LAB: DSC- 3 **LAB: PHYSICAL CHEMISTRY**

Program: M.Sc.
Course: Discipline Specific Core
Semester: I

Subject Code P26/CHE/DSC/203/P
No. of Hrs. allotted: 4 Hrs / week
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 I_2

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 I_2 between cyclohexane and water
2. Distribution of I_2 between cyclohexane and aq. KI solution - calculation of equilibrium constant.

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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 IN HCI

12. Inversion of cane sugar catalyzed by 2N HCI

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

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Reference Books:

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla; R Chand & Co., 2018

2. Experimental Physical Chemistry: V. Athawale and P. Mathur, New Age, International 2001

3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan, Viva Books, 2012

4. Practical in Physical Chemistry: P.S. Sindhu, Lakshmi Publications, 2009

5. Advanced Practical Physical chemistry: J.B.Yadav, Krishna Prakashan Media, 2016

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PHYSICAL CHEMISTRY

PRACTICAL MODEL PAPER

Course Code: P26/CHE/DSC/203/P **Max Time:3hrs**
Credits: 2 **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

e) Determine the concentration of KI using the distribution coefficient of I_2 between cyclohexane and aq. KI solution. **(CO1) 25 M**

Record and Attendance **5 M**

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. B. Uma Rani	Dr. Saritha Aduri	Prof. Uma Joseph

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