DEPARTMENT OF CHEMISTRY				*CLASS: I M.Sc. Chemistry*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
II	Major Core	21P2CMC5	Inorganic Chemistry - II	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

Objectives: ***The objective of this course is to make the student***

(i) To learn about thermodynamic and stereochemical aspects of complex formation

(ii) To learn about Various theories of complexes and their magnetic properties

(iii) To learn about term symbols and energy level diagram of weak and strong field ligands,charge transfer spectra ands pectral properties of lanthanides and actinides.

(iv)To learn about various mechanisms of substitution and electron transfer reactions.

Unit	Description	Hours	K-Level	CLO
I	**STABILITYOFCOMPLEXES** Stability of complexes- Factors affecting the stability of complexes, Thermodynamic and kinetic stability aspects ofcomplex formation,Stepwiseandoverall formation constants, Stability correlations, statisticalfactors and chelate effect, Determination of stability constant and composition of the complexes: Bjerrum's method (Potentiometric method), Spectrophotometric method, Polorographic method and Continuous variation method (Job'smethod)	15	Up to K2	CLO-1
II	***METAL-LIGANDBONDING*** Crystal field theory – Splitting of d orbitals under various geometries - factors affectingsplitting, CFSE, evidences for CFSE(Structural and thermodynamic effects), spectrochemical series, Jorgensen relation, site preferences, Jahn Teller distortion – Dynamic and Static J.T.effect, Jahn Tellereffectandchelation,ApplicationofCFT– Magneticproperties,spectralpropertiesandKineticproperties,Limitations of CFT, Evidences for M-Loverlap. MOT – MO theory and energy level diagrams concept of Weak and strong fields, Sigmaand pi bonding in octahedral, square planar and tetrahedral complexes. Nephlauxetic effect, Magnetic properties of complexes. Comparison of CFT and MOT of bonding in octahedral complexes.	15	Up to K4	CLO-2

III	**ELECTRONICSPECTRAOFCOMPLEXES** Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state termsymbol, Hund's rule, Selection rules – breakdown of selection rules, spin orbit coupling, bandintensities, weak and strong field limits – correlation diagram, Energy level diagrams. OrgeldiagramforweakfieldOhandTdcomplexes–Splitting ofenergylevelduetoJahn-Teller distortion. Modifiedorgel diagram– Limitiations of orgeldiagram and Tanabe–Sugano(T-S)diagrams – Evaluation of Dq and B values for d^2 –d^8 complexes, charge transfer spectra. Comparison between d-d bands and CTbands – Numerical problems, Lanthanides and Actinides-Spectral properties.	15	Up to K3	CLO-3
IV	**INORGANICREACTION MECHANISM-I** Stereochemical aspects- Stereoisomerism in inorganic complexes-Isomerism arising out ofliganddistribution and ligand conformation, Chirality andnomenclature of chiral complexes; Application of ORD and CD in the identification of complexes. Macrocyclicligands-Porphyrins,Corrins, Schiff'sbases, crowne thers,etc. Electron transfer reactions– Inner sphere (ISET) and outer sphere (OSET) electrontransfer reactions. Role of bridging ligand with ISET reaction – tunneling transfer – multiple bridging in the activated complex in the ISET process. Complimentary and non complimentary ETreactions. Crossreactions and marcus Hush theory.	15	Up to K4	CLO-4
V	**INORGANICREACTION MECHANISM-II** Reactionmechanismofcoordinationcompounds– Typesofligandsubstitutionreactions – mechanism; Dissociative mechanism (D), Associative mechanism (A) interchange mechanism(I),LabileandInertcomplexes.SubstitutionReactioninoctahedralcomplexes–generalmechanism, general rate law for D,A and I - distinction between D, A, I pathways, replacementof coordinated water, mechanism of acid hydrolysis, base hydrolysis – DCB mechanism – direct and indirect evidences in favour of the mechanism. Anation Reactions. Substitution in square planar complexes – Generalmechanism, Trans effect, influences of entering and leaving groups. Application of trans effect –synthesis and isomers of Pt(II) complexes – theories of trans effect and cis-trans isomerisation reaction. Application of substitution reactions in the synthesis of Platinum and Cobalt complexes.	15	Up to K4	CLO-5

Booksfor study:

1. F. Basolo and R. G. Pearson, Mechanism of Inorganic reactions, Wiley Eastern, 1967.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic chemistry-Principles on structure and reactivity, 4th Ed, Pearson- education, 2002.
3. K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Sanders Co, USA, 1977.

Books for reference:

1. D. F. Shriver, P. W. Atkins and C. H. Longford, Inorganic Chemistry, ELBS, 2nd Ed, 1994.
2. R. B. Heslop and K. Jones, Inorganic Chemistry, Elsevier, 1976.
3. D. Bannerjea, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.
4. M. L. Tobe, Inorganic Reaction Mechanism, Nelson, 1972.
5. K. Burjer, Co-ordination Chemistry Experimental Methods, Butterworths, 1973.
6. B. N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd, 1976.

Web resources

1. https://www.intechopen.com/books/stability-and-applications-of-coordination-compounds/stability-of-metal-complexes
2. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book%3A_Inorganic_Chemistry_(Saito)/06%3A_Chemistry_of_Transition_Metals/6.06%3A_Reactions_of_Complexes
3. https://chem.libretexts.org/Courses/Saint_Marys_College_Notre_Dame_IN/CHEM_431%3A_Inorganic_Chemistry_(Haas)/CHEM_431_Readings/13%3A_Spectroscopic_and_Magnetic_Properties/13.02%3A_Electronic_Spectra_of_Coordination_Compounds

Rationale for Nature of the course

This course should enable the students to comprehend the basic concepts and structure of of co-ordination complex , understand the reaction mechanism & the path-ways to prove it, electronic spectra of complexes and lanthanide and actinides complex also.

Activities having direct bearing on Skill development/ Employability/Entrepreneurship

To ensure the basic knowledge and structural elucidation of metal complexes and their stability which confirmed by spectral techniques. To understand the reaction pathway and its mechanism of metal complexes to ensure the stability of metal complexes. Students should learn the basic idea of term symbol and applied to the complexes and study their spectral properties.

Pedagogy:

- Chalk-Talk Class room Activities
- Seminar
- Assignment and Quiz through ICT

Lesson plan:

Unit	Topics	Hours	Mode
I	**STABILITY OF COMPLEXES**		BB/PPT/ AnimatedVideos
	Stability of complexes- Factors affecting stability of complexes,	3	
	Thermodynamic and kinetic stability aspects of complex formation,Stepwise and overall formation constants	4	
	Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum's half method, Potentiometric method	4	
	Spectrophotometric method, Ion exchange method, Polorographic method and Continuous variation method (Job's method)	4	
	METAL LIGAND BONDING		
II	Crystal field theory – Splitting of d orbitals under various geometries	2	BB/PPT/ AnimatedVideos
	Factors affecting splitting, CFSE, evidences for CFSE(Structural and thermodynamic effects), spectrochemical series, Jorgensen relation, site preferences.	2	
	Jahn Teller distortion – Dynamic and Static J.T. effect, and chelation.	2	
	Application of CFT – Magnetic properties, spectral properties and Kinetic properties, Limitations of CFT, Evidences for M-L overlap.	3	
	MOT – MO theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes.	3	
	Nephlauxetic effect, Magnetic properties of complexes. Comparison of CFT and MOT of bonding in octahedral complexes.	3	
III	**ELECTRONIC SPECTRA OF COMPLEXES**		
	Spectroscopic term symbols for d^n ions – derivation of term symbols and ground state term symbol, Hund's rule, Selection rules – breakdown of selection rules, spin orbit coupling, band intensities, weak and strong field limits – correlation diagram,	3	BB/PPT/ AnimatedVideos
	Energy level diagrams. Orgel diagram for weak field Oh and Td complexes – Splitting of energy level due to Jahn-Teller distortion.	3	
	Modified orgel diagram – Limitations of orgel diagram and Tanabe–Sugano(T-S) diagrams	3	
	Evaluation of Dq and B values for d^2 –d^8 complexes charge transfer spectra	3	
	Comparison between d-d bands and CT bands – Numerical problems, Lanthanides and Actinides- Spectral properties	3	

	INORGANIC REACTION MECHANISM-I		
	Stereochemical aspects- Stereoisomerism in inorganic complexes- Isomerism arising out of ligand distribution and ligand conformation, Chirality and nomenclature of chiral complexes;	3	BB/PPT/ AnimatedVideos
	Application of ORD and CD in the identification of complexes.	3	
IV	Macrocyclic ligands- Porphyrins, Corrins, Schiff's bases, crown ethers, etc.	3	
	Electron transfer reactions – Inner sphere (ISET) and outer sphere (OSET) electron transfer processes. Role of bridging ligand with ISET reaction – tunneling transfer – multiple bridging in the activated complex in the ISET process.	3	
	Complimentary and non-complimentary ET reactions. Cross reactions and marcus Hush theory.	3	
	INORGANIC REACTION MECHANISM-II		
	Reaction mechanism of coordination compounds – Types of ligand substitution reactions – mechanism; Dissociative mechanism (D), Associative mechanism (A) interchange mechanism (I), Labile and Inert complexes.	3	BB/PPT/ AnimatedVideos
V	Substitution Reaction in octahedral complexes – general mechanism, general rate law for D, A and I - distinction between D, A, I pathways, replacement of coordinated water, mechanism of acid hydrolysis, base hydrolysis – DCB mechanism – direct and indirect evidences in favour of the mechanism.	3	
	Anation Reactions. Substituion in square planar complexes – General mechanism, Trans effect, influences of entering and leaving groups.	3	
	Application of trans effect – synthesis and isomers of Pt(II) complexes – theories of trans effect and cis-trans isomerisation reaction.	3	
	Application of substitution reactions in the synthesis of Platinum and Cobalt complexes	3	

Course Learningoutcome:

After successful completion of this course, the student will be able

CLO	CLO statement	Knowledge level
CLO1	To learn stability and stereochemistry of metal complexes	Up to K2
CLO2	To explain metal ligand bonding using CFT and MOT in various geometrical environments	Up to K4
CLO3	To interpret the electronic spectra for the determination of the structure of complexes	Up to K3
CLO4	To evaluate electron transfer reactions of octahedral and tetrahedral complex	Up to K4
CLO5	To analyses and apply the substitution reaction and trans effect in complex	Up to K4

Mapping of CLOs with PLOs

	PLO1	PLO 2	PLO 3	PLO4	PLO5
CLO1	2		3	1	2
CLO2	2		3	1	2
CLO3	2		3	1	2
CLO4	2		3	1	2
CLO5	2		3	1	2

3-Advance application; 2-Intermediate level; 1-Basic level

Components of Formative Assessment	Marks	K level
Internal Test	**10**	As per below table
Assignment	**5**	K4
Quiz	**5**	K4
Seminar	**5**	K4
Total	**25**	

Learning Outcome Based Education(LOBE) & Assessment

Formative Examinations I & II -Blue Print

Articulation Mapping - K Levels with Course Outcomes (CLOs)

Units	CLOs	K- Level	SectionA		Section B (Either/or Choice)	Section C (Open Choice)
			Short Answers			
			No. of Questions	K Level		
1	CLO x	Up to K3	2	K2,K3	2 (K3&K3)	2(K2/K3)
2	CLO y	Up to K4	3	K2, K2, K3	2 (K4&K4)	1(K3/K4)
No. of Questions to be asked			5		4	3
No. of Questions to be answered			5		2	2
Marks for each question			2		5	10
Total Marks for each section			10		10	20

K1- Remembering and recalling facts with specific answers
K2- Basic understanding of facts and stating main ideas with general answers
K3- Application oriented- Solving Problems
K4- Examining, analyzing, presentation and make inferences with evidences

Learning Outcome Based Education (LOBE) & Assessment
Summative Examination – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

S. No.	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2 (K1 & K1)	1(K2)
2	CLO 2	Up to K4	2	K3 & K4	1	K2	2 (K4 & K4)	1(K4)
3	CLO 3	Up to K3	2	K2 & K3	1	K1	2 (K2 & K2)	1(K3)
4	CLO 4	Up to K4	2	K3 & K4	1	K2	2 (K4 & K4)	1(K4)
5	CLO 5	Up to K4	2	K2 & K3	1	K3	2 (K3 & K3)	1(K3)
No. of Questions to be asked			**10**		**5**		**10**	**5**
No. of Questions to be answered			**10**		**5**		**5**	**3**
Marks for each question			**1**		**2**		**5**	**10**
Total Marks for each section			**10**		**10**		**25**	**30**

K1- Remembering and recalling facts with specific answers
K2- Basic understanding of facts and stating main ideas with general answers
K3- Application oriented- Solving Problems
K4- Examining, analyzing, presentation and make inferences with evidences

Distribution of Section-wise Marks with K Levels

K Levels	Section A& B (No Choice)	Section C (Either / or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated %
K1	6	10	-	16	13.3	35
K2	6	10	10	26	21.7	
K3	6	10	20	36	30	30
K4	2	20	20	42	35	35
Total marks	**20**	**50**	**50**	**120**	**100**	**100**

Name of the course Designers

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2. Dr. P. Gajendran