DEPARTMENT OF CHEMISTRY				*CLASS: I M.Sc. Chemistry*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
I	Major Core	21P1CMC2	Inorganic Chemistry - I	4	5	25	75	100

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

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

(i) To understand the basic and advanced concepts in bonding and enable the students to identify the structure and bonding of simple molecules.

(ii) To study the various types of packing in solids

(iii) To provide knowledge of band theories and diffraction studies

(iv) To understand knowledge of the structure and bonding in boron compounds.

(v) *To enable students appreciate the structure of inorganic chain and cluster compounds.*

Unit	Course Contents	Hours	K-Level	CLO
I	**CHEMICAL BONDING** Valence bond approach to bonding-Hitler-London, Pauling and Slater refinements, concept of hybridization and structure of molecules, VSEPR theory shapes of molecules. M.O. approach to covalent bonding – symmetry and overlap of atomic orbitals – symmetry of molecular orbitals – Weak Chemical forces: van der Waals forces, Hydrogen bondingsigma and pi bonding – energy levels in homo and hetero nuclear diatomic systems – bond length, bond order and bond energy, Application to small molecules such as $BeCl_2$, BCl_3 and CCl_4, SF_4, etc, ionic character in a covalent bond - The concept of multicenter bonding. pseudo halogens: Structure and bonding in ClF_3, BrF_3, BrF_5 , IF_5, IF_7etc . Oxides and oxyacids of halogens, bonding in noble gas compounds – $XeCl_2$, XeF_4, $XeOF_4$, XeF_6.	15	Up to K3	CLO-1
II	**CHEMISTRY OF SOLID STATE I: STRUCTURE** Close packing of atoms and ions HCP and BCC types of packing voids, radius ratio – derivation – its influence on structures. Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant. Representative structures of AB and AB_2 types of compounds - rock salt, cesium chloride, wurtzite, zinc blende, rutile, fluorite, antifluorite, cadmium iodide and nickel arsenide. Structure of graphite and diamond. Spinels -normal and inverse types and perovskite structures.	15	Up to K4	CLO-2

III	**CHEMISTRY OF SOLID STATE II: DIFFRACTION METHODS** Band theory of solids- non-stoichiometry- point defects – linear defects- effects due to dislocations-electrical properties of solids-conductor, insulator, semiconductor-intrinsic-impurity semiconductors-optical properties-lasers and phosphors-elementary study of liquid crystals. Difference between point group and space group – screw axis – glide plane - symmetry elements –relationship between molecular symmetry and crystallographic symmetry – The Concept of reciprocal lattice – X-ray diffraction by single crystal – rotating crystal – powder diffraction. Neutron diffraction: Elementary treatment – comparison with X-ray diffraction. Electron diffraction- Basic principle. Crystal Growth methods: (hydrothermal andgel methods).	15	Up to K2	CLO-3
IV	**BORONCOMPOUNDS AND CLUSTERS** Chemistry of boron – boranes, higher boranes, borazines , boron nitrides, hydroborate ions – Preparation, properties and structure, STYX numbers, Wade's rules. Carboranes- Types such as nido-closo, arachno-preaprtion properties and Structure. Metallocarboranes-a general study. Metal clusters: Chemistry of low nuclearity metal clusters only, Structure of Re_2Cl_8; multiple metal-metal bonds.	15	Up to K4	CLO-4
V	**INORGANIC CHAIN AND CLUSTER COMPOUNDS** Types of inorganic polymers, comparison with organic polymers, silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes. P-N compounds, cyclophosphazenes and S-N compounds – S_4N_4, (SN)x. Isopoly and heteropoly acids – Structure and bonding of 6- and 12 – isopoly and heteropoly anions. Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro silicates – one dimensional, two dimensional and three dimensional silicates.	15	Up to K4	CLO-5

Books for study:

1. R. D. Madan, Modern Inorganic Chemistry, 3rdedn, S. Chand & Company Ltd., Reprint2014.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic chemistry-Principles on structure and reactivity, 4th Ed, Pearson- education, 2002.
3. F. A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, Wiley Eastern, 1988.
4. K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Sanders Co, USA, 1977.
5. Concise Inorganic Chemistry: Fifth Edition by J.D. Lee.

Books for Reference:

1. P.L. Soni, Text book of Inorganic Chemistry, 20th edn, Sultan Chand& Sons,2000.
2. Puri B.R.. Sharma L.R., Kalia K.K principles of Inorganic chemistry.35th edition, New edition: Shoban Lal Nagin Chand and co. 2013
3. R. B. Heslop and K. Jones, Inorganic Chemistry, Elsevier, 1976.
4. Sp. Banerjee, Advanced Inorganic Chemistry 2nd edn, Vol- and 2ArunabhaSen, Books and Allied (P) Ltd., Kolkata,2017.
5. Sathya Prakash, Tuli, Basu& Madan, Advanced Inorganic Chemistry. Vol. II , 17th edition, 1999.

Web references

1. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2011/06/VSEPR-Theory.pdf,http://www.idconline.com/technical_references/pdfs/chemical_engineering/Valence_bond_theory.pdf,https://chemistry.tcd.ie/assets/pdf/sf-chemistry/Molecular_Orbital_Theory.pdf,https://byjus.com/jee/hybridization/
2. https://ncert.nic.in/ncerts/l/lech101.pdf,https://www.vedantu.com/revision-notes/cbse-class-12-chemistry-notes-chapter-1-the-solid-state
3. http://web.iitd.ac.in/~elias/links/Elias%20lectures%20boron%20chemistry%202015%20final%2011th%20sept.pdf
4. http://ggu.ac.in/download/IT/Dr%20S%20S%20Thakur%20and%20Dr%20G%20K%20Patra%20M%20Sc%20IV%20Sem-Inorganic%20Chemistry-S-2-AR7148.pdf,
5. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/11.inorganic_chemistry-iii/29._metal-metal_bonds_and_their_evidences/et/9108_et_et_29.pdf
6. https://ipsonline.in/Files/2006/JanMar/ReviewArticle2.pdf
7. http://www.fhiberlin.mpg.de/acnew/department/pages/teaching/pages/teaching__wintersemester__2016_2017/thomas_lunkenbein__structural_chemistry_of_silicates__170127.pdf

Rationale for Nature of the course

The basic knowledge, concept of valence bond theory, VSEPR theory, Molecular orbital theory and study of bonding nature, structural elucidation and arrangement of atoms in a molecule with help of X-ray diffraction analysis in solid state chemistry, the boron compounds and cluster compounds will help the student to understand the structure, bonding and types of molecules.

Activities having direct bearing on Skill development/ Employability/Entrepreneurship

To comprehend the formation of new modules for the framing the structure of the molecule and their properties which ensure the knowledge of pathway of inorganic reactions.

Pedagogy

- Chalk-Talk class room Activities
- Group Discussion
- Seminar
- Quiz through ICT- Mode

Lesson plan:

Unit	Descriptions	Hours	Lecture Mode
I	**CHEMICAL BONDING**		
	V.B. approach to bonding-Hitler-London, Pauling and Slater refinements, Concept of hybridization and structure of molecules, VSEPR theory shapes of molecules	3	BB/PPT/ AnimatedVideos
	M.O. approach to covalent bonding – symmetry and overlap of atomic orbitals – symmetry of molecular orbitals, sigma and pi bonding, Weak Chemical forces: van der Waals forces, Hydrogen bonding.	3	BB/PPT/ AnimatedVideos
	sigma and pi bonding Energy levels in homo and hetero nuclear diatomic systems, bond length, bond order and bond energy	3	BB/PPT/ AnimatedVideos
	Application to small molecules such as $BeCl_2$, BCl_3 and CCl_4, SF_4, etc, Ionic character in a covalent bond, The concept of multicenter bonding	2	BB/PPT/ AnimatedVideos
	Pseudo halogens, Structure and bonding in ClF_3, BrF_3, BrF_5, IF_5, IF_7 etc.	2	BB/PPT/ AnimatedVideos
	Oxides and oxyacids of halogens, Bonding in Noble gas compounds – $XeCl_2$, XeF_4, $XeOF_4$, XeF_6	2	BB/PPT/ AnimatedVideos
II	**CHEMISTRY OF SOLID STATE I: STRUCTURE**		
	Close packing of atoms and ions HCP types of packing voids	3	BB/PPT/ AnimatedVideos
	Close packing of atoms and ions BCC types of packing voids, ratio – derivation – its influence on structures	3	BB/PPT/ AnimatedVideos
	Lattice energy – Born-Lande equation, Kapustinski equation, Madelung constant.	3	BB/PPT/ AnimatedVideos
	Representative structures of AB and AB_2 types of compounds - rock salt, cesium chloride, wurtzite	2	BB/PPT/ AnimatedVideos
	zinc blende, rutile, fluorite, antifluorite, cadmium iodide, Nickel arsenide.	2	BB/PPT/ AnimatedVideos
	Structure of graphite and diamond, Spinels -normal and inverse types and perovskite structures	2	BB/PPT/ AnimatedVideos
III	**CHEMISTRY OF SOLID STATE II: DIFFRACTION METHODS**		
	Band theory of solids- non-stoichiometry- point defects, linear defects- effects due to dislocations	3	BB/PPT/ AnimatedVideos
	electrical properties of solids-conductor, insulator, semiconductor-intrinsic-impurity semiconductors	3	BB/PPT/ AnimatedVideos
	optical properties-lasers and phosphors-elementary study of liquid crystals, Difference between point group and space group	3	BB/PPT/ AnimatedVideos
	screw axis and glide plane, symmetry elements–relationship between molecular symmetry and crystallographic symmetry	2	BB/PPT/ AnimatedVideos
	The Concept of reciprocal lattice, X-ray diffraction by single crystal – rotating crystal, powder diffraction	2	BB/PPT/ AnimatedVideos
	Neutron diffraction: Elementary treatment – comparison with X-ray diffraction, Electron diffraction- Basic principle. Crystal Growth methods: From melt and solution (hydrothermal, Gel methods).	2	BB/PPT/ AnimatedVideos

IV	**BORONCOMPOUNDS AND CLUSTERS**		
	Chemistry of boron – boranes, higher boranes, borazines, boron nitrides	3	BB/PPT/ AnimatedVideos
	hydroborate ions – Preparation, properties, hydroborate ions-structure	3	BB/PPT/ AnimatedVideos
	STYX numbers, Wade's rules, Carboranes, Carboranes types such as nido-closo- preaprtion properties and Structure	3	BB/PPT/ AnimatedVideos
	Carboranes types such as nido-closo- preaprtion properties and Structure	2	BB/PPT/ AnimatedVideos
	Carboranes types such as arachno- preaprtion properties and Structure, Metallocarboranes-a general study	2	BB/PPT/ AnimatedVideos
	Metal clusters: Chemistry of low nuclearity metal clusters only, Structure of Re_2Cl_8; multiple metal-metal bonds	2	BB/PPT/ AnimatedVideos
V	**INORGANIC CHAIN AND CLUSTER COMPOUNDS**		
	Types of inorganic polymers, Types of inorganic polymers-comparison with organic polymers	3	BB/PPT/ AnimatedVideos
	silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes	3	BB/PPT/ AnimatedVideos
	P-N compounds, cyclophosphazenes, S-N compounds – S_4N_4, (SN)x	3	BB/PPT/ AnimatedVideos
	Isopoly acids – Structure and bonding of 6- and 12– isopoly anions, heteropoly acids – Structure and bonding of 6- and 12– heteropoly anions.	2	BB/PPT/ AnimatedVideos
	Structure of silicates, applications of Paulings rule of electrovalence	2	BB/PPT/ AnimatedVideos
	isomorphous replacements in silicates -ortho, meta and pyro silicates, one dimensional, two dimensional and three dimensional silicates.	2	BB/PPT/ AnimatedVideos

BB-Blockboard/ChalkandTalk
PPT-Powerpointpresentation

Course learning outcome:

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

CLOs	CLO statement	Knowledge level
CLO1	To predict the structure and types of bond in inorganic molecules using VB and MO theories	Up to K3
CLO2	To illustrate the various types packing in solids	Up to K4
CLO3	To organize the knowledge on band theories of solids and diffraction studies	Up to K2
CLO4	To infer knowledge about structure and bonding in boron compounds	Up to K4
CLO5	To illustrate the structure of inorganic chain and cluster compounds	Up to K4

PLOand CLOMapping

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
CLO 1	1		3	1	2
CLO 2	1		3	1	2
CLO 3	1		3	1	2
CLO 4	1		3	1	2
CLO 5	1		3	1	2

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

Internal Assessment : 25 Marks
External Assessment : 75 Marks
Total : 100 Marks

Components of FormativeAssessment	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 – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	CLOs	K- Level	SectionA Short Answers		Section B (Either/or Choice)	Section C (Open Choice)
			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 MCQs		Section B Short Answers		Section C (Either/or Choice)	Section D (Open Choice)
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K3	2	K2 & K3	1	K1	2 (K2& K2)	1(K3)
2	CLO 2	Up to K4	2	K2 & K3	1	K3	2 (K3 & K3)	1(K3)
3	CLO 3	Up to K2	2	K1 & K1	1	K1	2 (K1& K1)	1(K2)
4	CLO 4	Up to K4	2	K3 & K4	1	K2	2 (K4 & K4)	1(K4)
5	CLO 5	Up to K4	2	K3 & K4	1	K2	2 (K4 & K4)	1(K4)
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

Name of the course Designers

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2. Dr. A. Xavier