University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK1DSCCHE102**				
Course Title	**CHEMICAL FRONTIERS – BONDING TO ENVIRONMENTAL PERSPECTIVES**				
Type of Course	**DSC**				
Semester	1				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Higher secondary level science knowledge				
Course Summary	The course covers the periodic classification of elements, chemical bonding, organometallic chemistry, environmental pollution, and analytical principles, including volumetric analysis. Students learn about quantum numbers, orbital concepts, electron configuration, bond energetics, molecular geometry, and various analytical techniques for qualitative and quantitative analysis. They also gain an understanding of the biological, environmental, and industrial applications of chemistry.				

Detailed Syllabus:

Module	Unit	Content CHEMICAL FRONTIERS – BONDING TO ENVIRONMENTAL PERSPECTIVES	Hrs 75
1	**PERIODIC CLASSIFICATION OF ELEMENTS**		**9**
	1	Quantum numbers and their significance, Concept of orbitals.	2
	2	Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, stability of filled and half-filled orbitals.	2
	3	Electronic configuration and classification of elements in to s, p, d and f blocks	1
	4	Periodic properties, Ionisation energy, Electronegativity and Electron affinity. Diagonal relationship.	2
	5	Important characteristics of representative elements: valency, oxidation states, ionic and covalent bond formation Important characteristics of transition elements: variable valency and oxidation states, formation of Complex compounds.	2
II	**CHEMICAL BONDING**		**9**

	6	Energetic of bond formation – Types of Chemical bonds – Energetics of ionic bond formation – Lattice energy – Born Haber Cycle - Fajan's rules.	2
	7	Polarity of covalent bond its relation with electronegativity - Electro negativity scale – Pauling approach, Dipole moment – its relation to geometry.	2
	8	Hydrogen bond – inter and intra molecular – its consequences on boiling point, volatility and solubility.	1
	9	Concept of Hybridisation– sp, sp^2, sp^3, dsp^2, dsp^3, sp^3d^2, and sp^3d^3 with examples Explanation of bond angle in water and ammonia - VSEPR theory, geometry of molecules with bond pairs of electrons, bond pairs and lone pairs of electrons, limitations of VSEPR Theory.	2
	10	A brief review of molecular orbital approach, LCAO method – bond order, bond distance and stability of O_2, O_2^{2+}, O_2^{2-} , NO, NO^+, CO and HF.	2
III	**ORGANOMETALLICS**		**9**
	11	Definition and classification, Organo metallic compounds of Mg, Sn, Li, Hg, Fe and their synthesis, applications	3
	12	Biological and environmental aspects of organic compounds – organometallic compounds in medicines – organomercury, organoboron, organosilicon and organoarsenic compounds	2
	13	Outline of preparation and uses Antitumour drugs, silylated derivatives of bioactive organic compounds in agriculture and horticulture	3
	14	Environmental aspects of Organometallic compounds	1
IV	**ENVIRONMENTAL POLLUTION AND ANALYTICAL PRINCIPLES**		**18**
	15	Air pollution: Composition of air, major causes of air pollution	2
	16	Pollutants in air-carbon monoxide, carbon dioxide, oxides of Nitrogen and sulphur, chlorofluoro carbons- effect of using refrigerators and air conditioners, Particulate matter- Acid rain, Greenhouse effect, Ozone layer and its depletion	2
	17	Water pollution: causes- heat, industrial waste, sewage water, detergents, agricultural pollutants	2
	18	Treatment of industrial waste water- Activated charcoal, Reverse osmosis Quality of drinking water- Indian Standard and WHO standard- Dissolved oxygen- BOD, COD	2
	19	Soil pollution: pesticides, fertilizers, Industrial waste, Plastic.	1
	20	Principles of volumetric analysis- primary standard – standard solutions - normality and molarity	2
	21	Theory of acid - base titrations, permanganometric and dichrometric titrations, iodometric and complexometric titrations	2
	22	Theory of acid – base and redox indicators	2
	23	Beer- Lambert law- Principles of colorimetry – Estimation of Iron and phosphate	2
	24	Lab safety - Risk, Hazard, Chemical Hazard.	1
V	**VOLUMETRIC ANALYSIS**		**30**

	25	**Section A: Volumetric Analysis (5 Experiments (double titration) from Section A are compulsory)** 1. Preparation of standard solutions. 2. Neutralization Titrations a. Strong acid – Strong base b. Strong acid – Weak base c. Weak acid – Strong base 3. Redox Titrations - Permanganometry a. Estimation of oxalic acid. b. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.	15
	26	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add related experiments)** 1. Dichrometry 2. Iodometry & Iodimetry 3. Complexometry 4. Colorimetry	15

References

1. B.R Puri, L R Sharma K C Kalia, Principles of Inorganic Chemistry, Sobhanlal Nagin Chand & Co. New Delhi
2. Manas chanda, Atomic structure and Chemical bonding in molecular Spectroscopy, Tata Mc Graw Hill.
3. Malik, Tuli, Madan, Selected Topics in Inorganic chemistry, S Chand.
4. J D Lee, Concise Inorganic Chemistry, ELBS
5. D.A Skoog, D M West, F J, Holler, S R Crouch, Fundamentals of Analytical Chemistry,8th Edn., Brookes/Cole, Thomson Learning, Inc, USA, 2004.
6. A. I. Vogel, Quantitative Analysis.
7. Day and Underwood, Quantitative analysis: Laboratory manual.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Analyze the principles of quantum numbers and orbital concepts, apply electronic configuration and energy rules to classify elements into s, p, d, and f blocks, and critically evaluate periodic properties, bonding behavior, and characteristic oxidation states of representative and transition elements.	An	PSO-1
CO-2	Analyze the concepts of chemical bonding by evaluating the energetics of bond formation, ionic and covalent bond	An	PSO-1,2

	characteristics, hybridization types, molecular geometry using VSEPR theory, and molecular orbital theory to predict bond order, stability, and physical properties of molecules.		
CO3	Evaluate the synthesis, classification, and applications of organometallic compounds of key metals, assess their biological and environmental impacts, and critically analyze the role of organometallic compounds in medicine, agriculture, and environmental sustainability.	E	PSO-1,2,3
CO 4	Critically analyze the sources, effects, and mitigation techniques of air, water, and soil pollution, apply volumetric and colorimetric analytical methods including acid-base, redox, and complexometric titrations, and demonstrate comprehensive understanding of lab safety protocols to design effective environmental pollution management and chemical analysis strategies.	C	PSO-1,2,3
CO 5	Design and perform standard volumetric and instrumental analytical experiments to prepare solutions, estimate analytes through acid-base, redox, and complexometric titrations, and apply suitable methods for quantitative chemical analysis with scientific reasoning.	C	PSO-1,2,3,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMICAL FRONTIERS – BONDING TO ENVIRONMENTAL PERSPECTIVES

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PO-1,6 PSO-1	An	F, C	L	-
2	CO-2	PO-1,6 PSO-1,2	An	F, C	L	-
3	CO3	PO-1,3,6 PSO-1,2,3	E	F, C, P	L	-
4	CO 4	PO-1,6 PSO-1,2,3	C	F, C	L	-

5	CO 5	PO-1,2,3,6 PSO-1,2,3	C	F, C, P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	2	-	-	-	-	1	-	-	-	-	2	-	-
CO 2	2	1	-	-	-	1	-	-	-	-	2	-	-
CO 3	2	2	3	-	-	1	-	1	-	-	2	-	-
CO 4	2	1	3	-	-	1	-	-	-	-	2	-	-
CO 5	2	2	2	3	2	1	-	-	-	-	2	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓			✓