CO-PO attainment
in
Outcome Based Education
CCFUP UNDER NEP 2020

Department of Chemistry

Government General Degree College, Kalna-I

Program Outcome (PO)

- **PO1: Disciplinary knowledge**
- **PO2: Communication Skills**
- **PO3: Critical thinking**
- **PO4 : Problem solving**
- **PO5: Self-directed learning**
- **PO6: Research-related skills**
- **PO7: Scientific reasoning**
- **PO8: Information/digital literacy**
- **PO9: Lifelong learning**

Program Specific Outcome (PSO): UG Chemistrty

- **PSO1: Foundation for Theoretical Concepts of Chemistry: To know the fundamentals, principles and theoretical methodologies to explain chemistry around us.**
- **PSO2: Foundation for Experimental/Numerical tools of Chemistry: The ability to implement/visualize the theoretical knowledge through laboratory based experimental /numerical techniques.**
- **PSO3: Foundation for possible further developments: Inspire and boost interest to realize global issues and to create foundation for advanced studies, research and development in Chemistry.**

Course Content

Semester: I **Course name: Basic Chemistry-I**

Course Code: CHEM101-1 (Credits: Theory-03, Practicals-01)

Semester-I
Chemistry MAJOR
Paper code: CHEM101-1
Paper title: Basic Chemistry-I
Credits 3+1
FULL MARKS:40(THEORY)+20(PRACTICAL)+15(INTERNAL)=75
Theory: 60 Lectures

1. Atomic structure

Bohr's theory- its limitations and atomic spectra of hydrogen atom, Sommerfeld's theory, wave mechanics- de Broglie equation, Heisenberg's uncertainty principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2, quantum numbers and their significance, Radial and angular wave functions for hydrogen atom, radial and angular distribution curves, shapes of s, p, d and f orbitals, Pauli's exclusion principle, Hund's rules and multiplicity, exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30 *6 Hours*

2. Periodic properties

Modern IUPAC periodic table, effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction; ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and AllredRochow's scales) and factors influencing these properties, group electronegativities, group trends and periodic trends in these properties in respect of s-, p- and d-block elements, secondary periodicity, relativistic Effect, inert pair effect *6 Hours*

3. Acids and bases

Acid-Base concept- Arrhenius concept, theory of solvent system (in H2O, NH3, SO2 and HF); Bronsted-Lowry's concept, relative strength of acids, Pauling's rules, Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects, thermodynamic acidity parameters, Drago-Wayland equation, superacids, gas phase acidity and proton affinity, HSAB principle, acid-base equilibria in aqueous solution (proton transfer equilibria in water), pH, buffer, acid-base neutralisation curves, indicator, choice of indicators, concept of organic acids and bases, effect of structure, substituent and solvent on acidity and basicity, proton sponge, gas-phase acidity and basicity *6 Hours*

4. Fundamentals in Organic chemistry

Electron displacement phenomena and physical properties: inductive effect, field effect, hyperconjugation, mesomeric effect, resonance energy, bond polarization and bond polarizability, electromeric effect, steric effect, steric inhibition of resonance, influence of hybridization on bond properties, bond dissociation energy (BDE) and bond energy, bond distances, bond angles, concept of bond angle strain (Baeyer's strain theory), melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces, polarity of molecules and dipole moments, relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation, calculation of formal charges and double bond equivalent (DBE) Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes, benzynes and nitrenes, generation and stability, structure using orbital picture and electrophilic/nucleophilic behaviour of the reactive intermediates (elementary idea) Concept of aromaticity: Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring), concept of antiaromaticity and homoaromaticity, non-aromatic molecules, Frost diagram, elementary idea about α and β, measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene 12 *Hours*

5. Properties of Gases

Ideal and real gases: Deviation of gases from ideal behaviour, compressibility factor, Boyle temperature, Andrew's and Amagat's plots, van der Waals equation and its features, its derivation and application in explaining real gas behaviour, Dieterici equation of state, existence of critical state, critical constants in terms of van der Waals constants, law of corresponding states, virial equation of state, van der Waals equation expressed in virial form and significance of second virial coefficient, intermolecular forces (Debye, Keesom and London interactions, Lennard-Jones potential - elementary idea) *4 Hours*

6. Chemical Kinetics-I

Rate law, order and molecularity: Introduction of rate law, extent of reaction, rate constants, order, forms of rate equations of first-, second- and n-th order reactions, pseudo first-order reactions (example using acid catalyzed hydrolysis of methyl acetate), determination of order of a reaction by half-life and differential method, opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products with all steps of first order) Temperature and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation, rate-determining step and steady-state approximation – explanation with suitable examples. *5 Hours*

7. Thermodynamics-I

Zeroth and 1st law of Thermodynamics: intensive and extensive variables, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics,concept of heat q, work wand internal energy U, statement of first law, enthalpy H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions, Joule's experiment and its consequence Thermochemistry: standard states, heats of reaction, enthalpy of formation of molecules and ions and enthalpy of combustion and its applications, laws of thermochemistry, bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations andeffect of pressure on enthalpy of reactions, adiabatic flame temperature, explosion temperature *6 Hours*

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PRACTICALS:

(i) Separation, purification and melting point determination

Separation of components of a binary solid mixture based on solubility by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. NaHCO3, etc., purification of any one ofthe separated components by crystallization and determination of its melting point. Thecomposition of the mixture may be of the following types: Benzoic acid/*p*toluidine, *p* nitrotolune/*p*-anisidine, benzoic acid/benzophenone, urea/benzophenone, salicylic acid/*p*-nitrotoluene, etc. *12 Hours*

(ii) Determination of boiling point

Boiling points of common organic liquid compounds e.g., ethanol,cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc.

6 Hours

(ii) [Boiling points of the chosen organic compounds should preferably be less than 160°C]

(iii) Identification of a pure organic compound by chemical test(s)

Solid compounds: oxalic acid, succinic acid, resorcinol, urea, glucose and salicylic acid. Liquid Compounds: acetic acid, ethyl alcohol, acetone, aniline and nitrobenzene

12 Hours

Course Outcome (CO)		Paper: CHEM101-1		
Sl. No.	**Course Outcome (CO)**	**Knowledge Level**	**POs**	**PSOs**
Theory				
1	**Understand** bonding and orbital pictures of different organic molecules.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
2	**Define** the physical properties of molecules such as hybridization, bond dissociation energy, bond angle etc.	**L1:** Remembering	1, 2, 3, 4, 5, 6, 7, 8, 9	**1, 2, 3**
3	**Elementary idea** about classification of reaction mechanism.	**L2:** Understanding	1, 3, 4, 7, 8	**1, 2, 3**
4	**Identify** reactive intermediates.	**L4:** Analyzing	1, 3, 4, 5, 7, 8	**1, 2, 3**
5	**Predict** three dimensional geometries of molecules and point groups therein**.**	**L3:** Applying	1, 3, 4, 5, 7, 8	**1, 2, 3**
Practical				
1	**Understand** bonding and orbital pictures of different organic molecules.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
3	**Determination** of boiling point of common organic liquid compounds	**L5:** Evaluating	1, 2, 3, 4, 5, 6, 7, 8	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)

CO		Program Outcome (PO) & Program Specific Outcome (PSO)											
		PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO8	PO9	PSO 1	PSO 2	PSO 3
Theory	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
Practical	1	3	3	3	3	3	3	3	3	3	3	3	3
	2	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: I

Course Code: CHEM105-1

Course name: Drugs and pharmacuticals

(Credits: Theory-03)

Course Title: Drugs and pharmacuticals
(Credits: Theory-03)
F.M. = 50 (Theory-40, Internal Assesment-10)

Theory: 30 Lectures

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine). 18 classes

Course Outcome (CO) Paper: CHEM105-1

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	**Formulate** drug discovery, design and development; Basic Retrosynthetic approach.	**L6:** Creating	1, 3, 4, 5,6, 7, 8, 9	**1, 2, 3**
2	**Design** the **s**ynthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents, antibiotics, antibacterial and antifungal agents etc.	**L6:** Creating	1, 2, 3, 4, 5, 7, 8, 9	**1, 2, 3**
3	**Develop** the Knowledge about the application of different types medicine specifically.	**L3:** Applying	1, 2, 3 , 5, 6, 8, 9	**1, 2, 3**
4	**Illustrate** the production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	**L4:** Analyzing	1, 2, 4, 6, 7, 8, 9	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO) & Program Specific Outcome (PSO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3
1	3	3	2	-	2	-	-	-	2	3	2	2
2	3	3	2	2	2	-	2	-	2	3	2	2
3	2	2	3	3	3	2	3	-	3	2	3	3
4	3	3	3	3	3	-	3	2	3	3	3	3
Average	2.8	2.8	2.5	2.6	2.5	2.0	2.6	2.0	2.5	2.8	2.5	2.5

Course Content

Semester: II | **Course name: Basic Chemistry-II**

Course Code: CHEM201-1 (Credits: Theory-03, Practicals-01)

Semester-II
Chemistry MAJOR
Paper code: CHEM201-1
Paper title: Basic Chemistry-II
Credits 3+1
FULL MARKS:40(THEORY)+20(PRACTICAL)+15(INTERNAL)=75
Theory: 60 Lectures

1. Chemical bonding-I

Ionic bond: general characteristics, types of ions, size effects, radius ratio rule and its application and limitations, packing of ions in crystals Born-Landé equation with derivation and importance, Kapustinskii expression for lattice energy, Madelung constant, Born-Haber cycle and its application, solvation energy, solubility energetics of dissolution process.

Covalent bond: polarizing power and polarizability, ionic potential, Fazan's rules,Lewis structures, formal charge, Valence Bond Theory- hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach)

6 Hours

2. Redox Reactions and Precipitation Reactions

Balancing of redox reactions: ion-electron method, elementary idea on standard redox potentials- Nernst equation (without derivation), influence of complex formation, precipitation and pH, formal potential

Redox titrations: feasibility, redox potential at the equivalence point, redox indicators, redox potential diagram (Latimer and Frost diagrams) of common elements and their applications Disproportionation and comproportionation reactions (typical examples), solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides

4 Hours

3. Stereochemistry-I

Bonding geometries and representation of carbon compounds: tetrahedral nature of carbon and concept of asymmetry: Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations

Chirality and symmetry: symmetry elements and point groups (C_v, C_{nv}, C_{nh}, C_n, D_h, D_{nh}, D_{nd}, D_n, S_n (C_s, C_i)), molecular chirality and centre of chirality, asymmetric and dissymmetric molecules, enantiomers and diastereomers, epimers, stereogenicity, chirotopicity and pseudoasymmetry, chiral centres and number of stereoisomerism, systems involving 1/2/3-chiral centre(s)- AA, AB, ABA and ABC types

Relative and absolute configuration: D/L and R/S descriptors, erythro/threo and meso nomenclature of compounds, syn/anti nomenclatures for aldols, E/Z descriptors- C=C, conjugated diene, triene, C=N and N=N systems, combination of R/S- and E/Z-isomerisms

Optical activity compounds: optical rotation, specific rotation and molar rotation, racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates), resolution of acids, bases and alcohols via diastereomeric salt formation, optical purity and enantiomeric excess.

6 Hours

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4. General Treatment of Reaction Mechanism

Free energy profiles: one-, two- and three-step reactions, catalyzed reactions- electrophilic and nucleophilic catalysis, kinetic control and thermodynamic control of reactions, isotope effect- primary and secondary kinetic isotopic effect (k_H /k_D), principle of microscopic reversibility

Tautomerism: prototropy (keto-enol, amido-imidol, nitroso-oximino, diazo-amino and enamine-imine systems) and ring-chain tautomerism, composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism, application of thermodynamic principles in tautomeric equilibria

6 Hours

5. Substitution and Elimination Reactions

Nucleophilic substitution reactions: substitution at sp3 centre- mechanisms (with evidence), relative rates, stereochemical features, S_N1, S_N2, S_N2', S_N1' (allylic rearrangement) and S_Ni, effects of solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite), electrofuges and nucleofuges, substitutions involving NGP, role of crown ethers and phase transfer catalysts [systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides]

Elimination reactions: E_1, E_2, E_1cB and Ei (pyrolytic syn eliminations), formation of alkenes and alkynes, mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann) and stereoselectivity, comparison between substitution and elimination

6 Hours

6. Kinetic Theory of gases:

Concept of pressure and temperature; collision of gas molecules, collision diameter, collision number and mean free path, frequency of binary collisions (similar and different molecules), wall collision and rate of effusion

Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions, kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case, calculation of number of molecules having energy $\geq \varepsilon$, equipartition principle and its application to calculate

the classical limit of molar heat capacity of gases.

5 Hours

7. Liquid state

Viscosity: General features of fluid flow (streamline and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation; principle of determination of viscosity coefficient of liquids by falling sphere method; temperature variation of viscosity of liquids and comparison with that of gases

Surface tension and energy: Surface tension, surface energy, excess pressure, capillary rise and surface tension; work f cohesion and adhesion, spreading of liquids over other surfaces; vapour pressure over curved surface; temperature dependence of surface tension, principle of surface tension measurement

6 Hours

8. Thermodynamics-II

Second Law: its need and statement, concept of heat reservoirs and heat engines, Carnot cycle, physical concept of entropy, Carnot engine and refrigerator, Kelvin – Planck and Clausius statements and their equivalence in entropic formulation, Carnot's theorem,values of §dQ/T and Clausius inequality, entropy change of systems and surroundings for various processes and transformations, entropy and unavailable work, auxiliary state functions (G and A) and their variations (with T, P and V), criteria of spontaneity and equilibrium

Thermodynamic relations: Maxwell's relations, Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences, inversion temperature, Joule-Thomson coefficient for a van der Waals gas, general heat capacity relations.

6 Hours

Reference Books

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
4. Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
6. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.

PRACTICALS:.

1. Study of kinetics of acid-catalyzed hydrolysis of methyl acetate
2. Study of kinetics of decomposition of H2O2 by KI
3. Determination of pH of unknown strong alkali and acid solution by colour matching method
4. Determination of pH of unknown buffer solution by colour matching method
5. Study of viscosity of unknown liquid (glycerol, sugar) with respect to water
6. Determination of surface tension of a liquid using Stalagmometer

15 Hours

Course Outcome (CO)		Paper: CHEM101-1		
Sl. No.	**Course Outcome (CO)**	**Knowledge Level**	**POs**	**PSOs**
Theory				
1	**Understand** the various important features of redox reactions.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
2	**Define** the physical properties of molecules such as hybridization, bond dissociation energy, bond angle etc.	**L1:** Remembering	1, 2, 3, 4, 5, 6, 7, 8, 9	**1, 2, 3**
3	**Elementary idea** about the entropy and its utilities.	**L2:** Understanding	1, 3, 4, 7, 8	**1, 2, 3**
4	**Identify** the R/S nomenclature of various optically active organic molecules**.**	**L4:** Analyzing	1, 3, 4, 5, 7, 8	**1, 2, 3**
5	**Predict** spontaneity of the chemical reaction**.**	**L3:** Applying	1, 3, 4, 5, 7, 8	**1, 2, 3**
Practical				
1	**Understand** the different types of reaction kinetics**.**	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
3	**Determination** of viscosity and surface tension unknown organic liquid compounds	**L5:** Evaluating	1, 2, 3, 4, 5, 6, 7, 8	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)

	CO	Program Outcome (PO) & Program Specific Outcome (PSO)											
		PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO8	PO9	PSO 1	PSO 2	PSO 3
Theory	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
Practical	1	3	3	3	3	3	3	3	3	3	3	3	3
	2	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: I

Course Code: CHEM205-1

Course name: Basic Analytical Chemistry

(Credits: Theory-03)

Course Title: Drugs and pharmacuticals

(Credits: Theory-03)

F.M. = 50 (Theory-40, Internal Assesment-10)

Theory Credit 3

1. General principle

Introduction to analytical chemistry and its interdisciplinary nature, concept of sampling, importance of accuracy, precision and sources of error in analytical measurements, presentation of experimental data and results, role of significant figures

8 Hours

3. Analysis of soil

Composition of soil, concept of pH and pH measurement, complexometric titrations, chelation, chelating agents, use of indicators

6 Hours

3. Analysis of water

Definition of pure water, contaminants (different types), water sampling methods, water purification methods

6 Hours

4. Analysis of food products

Nutritional value of a food, idea about food processing and food preservations, and adulteration *6 Hours*

5. Chromatography

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc., column chomatography, ion-exchange chromatography, etc., determination of ion exchange capacity of anion /cation exchange resin *10 Hours*

6. Analysis of cosmetics

Major and minor constituents of cosmetics and their functions, analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate

9 Hours

Course Outcome (CO) Paper: CHEM105-1

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	**Construct** the easier methodology for the determination of the hardness of water.	**L6:** Creating	1, 3, 4, 5,6, 7, 8, 9	**1, 2, 3**
2	**Make** the TLC plate for chromatographic analysis.	**L6:** Creating	1, 2, 3, 4, 5, 7, 8, 9	**1, 2, 3**
3	**Develop** the Knowledge about the application of Standard deviation and variance.	**L3:** Applying	1, 2, 3 , 5, 6, 8, 9	**1, 2, 3**
4	**Illustrate** the process of analysis of soil, water cosmetics and food products.	**L4:** Analyzing	1, 2, 4, 6, 7, 8, 9	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO) & Program Specific Outcome (PSO)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3
1	3	3	2	-	2	-	-	-	2	3	2	2
2	3	3	2	2	2	-	2	-	2	3	2	2
3	2	2	3	3	3	2	3	-	3	2	3	3
4	3	3	3	3	3	-	3	2	3	3	3	3
Average	2.8	2.8	2.5	2.6	2.5	2.0	2.6	2.0	2.5	2.8	2.5	2.5

Course Content

Semester: III

Course name: Inorganic Chemistry (Theory)
Course Code: CHEM3011 (Credits: Theory-03, Practicals-01)

Semester-III
Chemistry MAJOR
Paper code: CHEM3011
Paper title: Inorganic Chemistry (Theory)
Credits 3+1
FULL MARKS:40(THEORY)+20(PRACTICAL)+15(INTERNAL)=75
Theory: 60 Lectures

1. Chemical Bonding-II

Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing, MO diagrams of H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+, CN^-, HF, BeH_2, CO_2 and H_2O. Bond properties: bond orders, bond lengths.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids – stoichiometric and non-stoichiometric.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points. *20 Hours*

2. Coordination Chemistry-I

Double and complex salts. Werner's theory of coordination complexes, Classification of ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes. *12 Hours*

3. Chemistry of s and p-block elements

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur. Sulphur-nitrogen compounds, Basic properties of halides and polyhalides, interhalogen compounds, pseudohalides, fluorocarbons and chlorofluorocarbons. *35 Hours*

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, structures (VSEPR theory) and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2 and XeF_4). Xenon-oxygen compounds. *8 Hours*

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Course Outcome (CO)		Paper: CHEM3011		
Sl. No.	**Course Outcome (CO)**	**Knowledge Level**	**POs**	**PSOs**
Theory				
1	**Understand** the various types of shapes and geometry of the chemical compound.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
2	**Define** the LCAO model in the light of quantum chemistry.	**L1:** Remembering	1, 2, 3, 4, 5, 6, 7, 8, 9	**1, 2, 3**
3	**Elementary idea** about the coordination number in metal complex.	**L2:** Understanding	1, 3, 4, 7, 8	**1, 2, 3**
4	**Identify** the different types of chemical bonding involved in the concerned chemical compound**.**	**L4:** Analyzing	1, 3, 4, 5, 7, 8	**1, 2, 3**
5	**Apply** the utilities of S/P block elements and their respective compounds in various purposes.	**L3:** Applying	1, 3, 4, 5, 7, 8	**1, 2, 3**
6	**Understand** the usefulness of Nobel gases.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
7	**Elucidate** the IUPAC nomenclature of different Coordination Compounds**.**	**L5:** Evaluating	1, 2, 3, 4, 5, 6, 7, 8	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)												
	CO	**Program Outcome (PO) & Program Specific Outcome (PSO)**										
		PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO8	PO9	PSO 1	PSO 2	PSO 3
THEOREY	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
	6	3	3	3	3	3	3	3	3	3	3	3	3
	7	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: III | **Course name: Inorganic Chemistry (Practical)**
Course Code: CHEM3012 (Credits: Theory-03, Practicals-01)

Semester-III
Chemistry MAJOR
Paper code: CHEM3012
Paper title: Inorganic Chemistry (Practical)
Credits 3+1
FULL MARKS:40(THEORY)+20(PRACTICAL)+15(INTERNAL)=75
Theory: 60 Lectures

1. *Qualitative analysis of Acid and Basic radicals from an inorganic sample* containing four radicals (oxide, hydroxide and carbonate may not be counted among four radicals). Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition. Semi-micro analysis may also be followed. The use of centrifuge machine, thioacetamide instead of H_2S and spot tests for specific radicals should be introduced

Basic radicals: Na^+, K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}/Mn^{4+}, Fe^{2+}/Fe^{3+}, Co^{2+}/Co^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}/Sn^{4+}, As^{3+}/As^{5+}, Sb^{3+}/Sb^{5+}, NH_4^+, Mg^{2+}.

Acid Radicals: F^-, Cl^-, Br^-, I^-, $S_2O_3^{2-}$, S^{2-}, SO_4^{2-}, SO_3^{2-}, NO_3^-, NO_2^- , PO_4^{3-}, AsO_4^{3-}, BO_3^{3-}, CrO_4^{2-}.

Insoluble Materials: Al_2O_3 (ig), Fe_2O_3 (ig), Cr_2O_3 (ig), SnO_2, $SrSO_4$, $BaSO_4$, CaF_2, $PbSO_4$.

45 Hours

2. *Inorganic preparations*

1) $[Cu(CH_3CN)_4]PF_6/ClO_4$
2) Potassium dioxalatodiaquachromate(III)
3) Tetraamminecarbonatocobalt(III) ion
4) Potassium tris(oxalato)ferrate(III)

5) Tris(ethylenediamine)nickel(II) chloride
6) $[Mn(acac)_3]$ and $[Fe(acac)_3]$ (acacH = acetylacetone)

Contd……

Course Outcome (CO)		Paper: CHEM3012		
Sl. No.	**Course Outcome (CO)**	**Knowledge Level**	**POs**	**PSOs**
Practical				
1	**Understand** the distinction between the acid and basic radical.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
2	**Define** the different types of methodologies of any radicals.	**L1:** Remembering	1, 2, 3, 4, 5, 6, 7, 8, 9	**1, 2, 3**
3	**Elementary idea** about insoluble materials in qualitative analysis.	**L2:** Understanding	1, 3, 4, 7, 8	**1, 2, 3**
4	**Identify** the acid and basic radicals in the unknown supplied sample**.**	**L4:** Analyzing	1, 3, 4, 5, 7, 8	**1, 2, 3**
5	**Apply** the different techniques for the determination of unknown sample.	**L3:** Applying	1, 3, 4, 5, 7, 8	**1, 2, 3**
6	**Understand** the benefits of prepared inorganic sample.	**L2:** Understanding	1, 2, 3, 4, 5, 8, 9	**1, 2, 3**
7	**Elucidate** the IUPAC nomenclature of different prepared inorganic sample.	**L5:** Evaluating	1, 2, 3, 4, 5, 6, 7, 8	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)												
	CO	**Program Outcome (PO) & Program Specific Outcome (PSO)**										
		PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO8	PO9	PSO 1	PSO 2	PSO 3
PRACTICAL	1	3	3	2	-	-	-	2	3	3	3	2	2
	2	3	3	2	2	2	2	2	2	2	2	2	2
	3	2	2	3	3	3	-	3	-	3	3	3	3
	4	3	3	3	3	3	3	3	2	2	2	3	3
	5	3	2	3	3	2	3	3	2	2	2	3	3
	6	3	3	3	3	3	3	3	3	3	3	3	3
	7	3	3	3	3	3	3	3	3	3	3	3	3
	Average	2.9	2.7	2.7	2.8	2.7	2.8	2.7	2.8	2.6	2.6	2.7	2.7

Course Content

Semester: III

Course name: IT Skill in Chemistry (SEC)
Course Code: CHEM3051 (Credits: Theory-03)

Course Title: IT Skill in Chemistry
(Credits: Theory-03)
F.M. = 50 (Theory-40, Internal Assesment-10)

Mathematical tools

1. Fundamentals: mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

2. Uncertainty in measurement: Displaying uncertainties, types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

3. Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary-bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

4. Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

5. Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

15 Hours

Computer Programming

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Fortran or C programming for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method). *15 Hours*

Handling numeric data

Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

15 Hours

Course Outcome (CO) Paper: SEC-3051

Sl. No.	Course Outcome (CO)	Knowledge Level (Bloom's Level)	POs	PSOs
1	**Formulate** fundamental mathematical functions and algebraic operations to measure data.	**L6:** Creating	1, 2, 3, 4, 5, 6, 7,8, 9	**1, 2, 3**
2	**Design** differential calculus and numerical integration for real measurements.	**L6:** Creating	1, 2, 3, 4, 5, 6, 7,8, 9	**1, 2, 3**
3	**Explain** basics of Computer Programming such as constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions etc.	**L2:** Understanding	1, 2, 3, 4,6,8,9	**1, 2, 3**
4	**Design** spreadsheet (Excel), entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs for handling numeric data.	**L6:** Creating	1, 2, 3, 4, 5, 6, 7,8, 9	**1, 2, 3**

Programme Articulation Matrix (CO-PO Matrix)

CO	Program Outcome (PO) & Program Specific Outcome (PSO)											
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3
1	3	3	2	3	2	3	3	3	2	3	3	2
2	3	3	2	2	3	3	2	2	2	3	3	3
3	2	2	3	3	-	2	-	3	3	2	2	3
4	3	3	3	2	3	3	3	2	3	2	3	3
Average	2.8	2.8	2.5	2.0	2.0	2.8	2.0	2.5	2.5	2.5	2.8	2.8