

Rajiv Gandhi University of Knowledge Technologies-AP

NUZVID**RK VALLEY**SRIKAKULAM**ONGOLE

**BOARD OF STUDIES - 2022
DEPARTMENT OF CHEMISTRY**



**CHEMISTRY COURSE STRUCTURE & SYLLABI
FOR
PUC & B.TECH PROGRAM**

Date & Time: 14/10/2022, 10.00AM;
Venue: Seminar hall, Guest House, RK Valley
Virtual meeting

Rajiv Gandhi University of Knowledge Technologies
DEPARTMENT OF CHEMISTRY

BOARD OF STUDIES

14th October 2022

AGENDA:

- Reframing of PUC Theory and Lab syllabi in accordance to the University guidelines
- Request for a proposal to retain the same syllabi for Engineering Chemistry courses and also for Minor in Chemistry courses as approved in the previous BoS, conducted on December-2020.
- Request for introducing Bachelor of Science or Master of Science/integrated M.Sc. program according to New Education Policy 2020

BOS - Members

S. No	Name of the member and Designation	Role
1	Prof. P. Jagadeeswara Rao, Director, RGUKT Srikakulam Campus	Chairperson
2	Prof. Amooru Gangaiah Damu, Department of Chemistry, Yogi Vemana University, Kadapa	Expert Member
3	Deans, Academics of constituent Institutes of RGUKT	Members
4	Prof. G. Ranga Rao, Department of Chemistry, IIT Madras	Expert Member
5	Prof. K. Laxmareddy, Professor, Department of Chemistry, NIT-Warangal	Expert Member
6	Heads of the Department of constituent Institutes of RGUKT	Members
7	Dr.S.Venkat Rao, Mentor, RGUKT-Nuzvid	Member
8	One student representative (Pre-Final Year student)	Member
9	Dr. P. Naga Ratna Kishore, Assistant Professor (C), RGUKT-RK Valley	Member- Convener

PUC – Chemistry

COURSE STRUCTURE

Course Code	Course Name	Course Category	L – T – P	C
20PCY1101	Chemistry – I	P1S1	4 – 2 – 0	4
20PCY1110	Chemistry Practicals-I	P1S1	0 – 0 – 2	1
20PCY1201	Chemistry – II	P1S2	4 – 2 – 0	4
20PCY1210	Chemistry Practicals-II	P1S2	0 – 0 – 2	1
20PCY2101	Chemistry – III	P2S1	4 – 2 – 0	4
20PCY2110	Chemistry Practicals-III	P2S1	0 – 0 – 2	1
20PCY220	Chemistry – IV	P2S2	4 – 2 – 0	4
20PCY2210	Chemistry Practicals-IV	P2S2	0 – 0 – 2	1

PUC-I

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY1101	CHEMISTRY - I	PUC	4 – 2 – 0	4

Course Learning Objectives:

1. To acquire knowledge about atomic structure and stability of an atom
2. To gain the knowledge of periodic classification, periodic properties and factors affecting these properties.
3. To acquire basic knowledge chemical bonding, types, characteristics and stability.
4. To acquire the knowledge of fundamental gas properties and establish relation between them
5. To get knowledge balancing of chemical equations.
6. To understand the properties of liquids and colligative properties

PUC I Semester I

UNIT-1: Basic concepts and Stoichiometry (12 Hours)

Atomic and molecular masses, naming of inorganic compounds, mole concept, the concept of molecular weight and equivalent weight. Percentage composition, calculations of empirical, molecular formulae. Balancing of chemical equations and stoichiometry, calculation of oxidation number and balancing Redox reactions using oxidation number method and ion-electron method.

UNIT-2: Atomic Structure (10Hours)

Wave nature of light, Plank's quantum theory and Photoelectric effect, Line spectra and Bohr's model, hydrogen spectra, limitations of Bohr's model. Wave nature of matter, De-Broglie's relationship, Heisenberg uncertainty principle. Schrodinger's wave equation and atomic orbitals, Quantum numbers, Rules for filling electrons in orbitals (Aufbau, Hund's & Pauli's principle), Electronic configuration of atoms.

UNIT-3: Periodic Classification (08 Hours)

Modern periodic law, Classification of elements. Periodicity and periodic trends in atomic radii and ionic radii. Ionization energy, successive ionization energies, periodic trends in first ionization energies. Electron affinity, electronegativity, metals, non-metals, and metalloids, valency.

UNIT-4: Chemical Bonding (12Hours)

Types of chemical bonds - ionic, covalent, metallic and co-ordinate covalent bond. Bond

polarity and dipole moment, Lewis symbols and Octet rule. Drawing Lewis structures and formal charge calculation. Valence bond theory-its limitations, VSEPR theory, concept of hybridization-postulates, the formation of sp , sp^2 , sp^3 , sp^3d and sp^3d^2 hybrid orbitals. Molecular orbital theory, molecular orbital energy level diagrams (H_2 to F_2). Inter molecular forces and hydrogen bonding, classification, and its consequences.

UNIT-5: Gaseous State (11 Hours)

Introduction to gases, characteristics, units of pressure, Gas laws-Boyle's law, Charles's law and Avagadro's law. Derivation of the ideal gas equation. Applications of ideal gas equation (Gas densities and molar mass), Dalton's Law of Partial pressures, and mole fractions. The kinetic molecular theory of gases-postulates and derivation of gas laws. Types of molecular velocities-average velocity, most probable velocity & RMS velocity. Deviation of Ideal behavior (van der Waal's gas equation concept and equation only). Graham's law of diffusion.

UNIT-6: Solutions (08 Hours)

Solutions and their properties, percent concentrations (w/w%, w/v% and v/v%), concentration terms-molarity, normality, molality, mole fraction and parts per million. Colligative properties of solutions-vapor pressure, and boiling point, lowering of vapor pressure, elevation of boiling point, depression of freezing point and osmotic pressure. Determination of molar mass from colligative properties.

Learning Resources:

Text books:

1. '*Chemistry, Text Book for Class XI*', National Council of Educational Research and Training, 2006
2. '*Chemistry Text Book for Intermediate First year*', Board of Intermediate AP

Reference Books:

1. *Elements of Physical Chemistry*, 7th Edition by **Peter Atkins** and **Julio de Paula**
2. *Concise Inorganic Chemistry*, 5th Edition by **J.D. Lee**
3. *Chemistry-The central science*, 13th edition, by **Theodore L. Brown**
4. *Chemistry and chemical reactivity*, 9th edition by **John C. Kotz** and **Paul M. Treichel**
5. *Chemistry: Principles and reactions*, 7th Edition by **Masterton, Hurley and Neth**

Web resources:

1. RGUKT course content
2. Swayam, *Chemistry*, <https://swayam.gov.in/chemistry/c/4/science>

Course outcomes: At the end of the course, the student will be able to

CO 1	Know the atomic structure and stability of an atom in detail
CO 2	Analyze the importance of periodic table and explain various periodic properties
CO 3	Determine the structure of simple molecules and predict the bond order
CO 4	Know the behavior of ideal gases and their deviation to real gases
CO 5	Balancing the chemical equations and finding the percentage compositions
CO 6	Know about the liquid state of matter and colligative properties

Assessment Method

Course Nature	Theory		
Assessment Tool	Monthly tests	End Semester Test	Total
Weightage (%)	40%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY11101	CHEMISTRY PRACTICALS-I	PUC1-SEM1	0 – 0 – 2	1

Course Learning Objectives:

1. To learn how to purify few of inorganic and organic compounds
2. To learn how to prepare a standard solution and its standardization

Practical Syllabus

1. Crystallization involving impure sample of any one of the following:

Alum, copper sulphate, Benzoic acid.

2. Preparation of Mohr's salt
3. Preparation of standard solution of oxalic acid.
4. Preparation of colloidal solutions

References:

Text books:

1. *Vogel's Quantitative Chemical Analysis*, SIXTH EDITION.
2. *Vogel's Qualitative Chemical Analysis*, SIXTH EDITION

Course Outcomes:

At the end of the course, the student will be able to purify a few double salts, organic compounds and standard solutions.

Assessment Method

Course Nature		Practical (Lab courses only)		
Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY1201	CHEMISTRY - II	PUC	4 – 2 – 0	4

Course Learning Objectives:

1. To know the fundamentals terms in thermodynamics and thermodynamic laws
2. To analyze the factors effecting position of equilibrium
3. To know the classification of acids and bases, buffers and solubility of sparingly soluble salts
4. To understand the nomenclature, isomerism, types of organic reactions
5. To know the preparation and properties of alkanes, alkenes and alkynes
6. To know the preparation and properties of benzene and aromatic compounds

PUC I Semester II

UNIT-1: Thermodynamics

(12Hours)

Introduction to thermodynamics, energy and surroundings, extensive and intensive properties, First law of thermodynamics, Enthalpy, enthalpies of reactions, Heat capacity and specific heat. Calorimetry, Hess's law – calculation of enthalpies of reaction, Spontaneous processes and Entropy, Second law of thermodynamics, Gibbs free energy and equilibrium constant.

UNIT-2: Chemical Equilibrium

(08 Hours)

Concept of Equilibrium, Law of mass action, equilibrium constant-its characteristics, calculating equilibrium constants. Applications of equilibrium constant (K_c), predicting the direction of reaction (K_c Vs Q). Factors affecting equilibrium constant, Le Chatelier's principle-its industrial applications in the synthesis of ammonia by Haber's process and sulfuric acid by contact process.

UNIT-3: Acids and bases

(10 Hours)

Theories of acids & bases- Arrhenius theory, Bronsted-Lowry theory [Conjugate acid-base concept], Lewis theory.

Ionic equilibrium- ionic product of water, concept of pH, pH scale, salt hydrolysis (concept and equation only), buffer solutions-definition, action of buffer, pH of buffer solutions (using Henderson - Hasselbalch equation-no derivation), solubility product, common ion effect – its applications.

UNIT-4: Introduction to Organic Chemistry

(10 Hours)

Introduction to Organic chemistry, classification and IUPAC nomenclature of organic compounds. Isomerism in organic compounds (structural and stereoisomerism), fission of

covalent bond, types of reagents and organic reactions (addition, substitution, elimination and rearrangement reactions), electronic displacements in covalent bonds-inductive effect, electromeric effect, mesomeric or resonance effect, and hyperconjugation.

UNIT-5: Chemistry of alkanes, alkenes and alkynes (12Hours)

Alkanes - Nomenclature, preparation of alkanes from alkenes, Wurtz reaction, Clemmenson reduction, Kolbe reaction, from Grignard reagent. Physical properties, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis.

Alkenes - Nomenclature, structure of double bond (ethene), methods of preparation (from alkynes, alkylhalides, vicinal dihalides and alcohols). Physical properties, chemical reactions: addition of hydrogen, halogen, water, hydrogen halides (Markownikov's addition and peroxide effect-including mechanism), ozonolysis, oxidation, mechanism of electrophilic addition.

Alkynes - Nomenclature, structure of triple bond (ethyne), methods of preparation (from geminal and vicinal dihalides), physical properties, chemical reactions: acidic character of alkynes, addition reaction of hydrogen, halogens, hydrogen halides and water.

UNIT-6: Benzene and Aromatic hydrocarbons (08Hours)

Aromatic Hydrocarbons: Introduction, structure of benzene, nomenclature of benzene and its compounds. Huckel's rule, and preparation of benzene from benzoic acid, phenol, aniline, and acetylene. Chemical properties: general mechanism of electrophilic substitution. Nitration, sulphonation, halogenation, Friedel-Craft's alkylation and acylation, reactivity and directive influence of functional group in mono-substituted benzene.

Learning Resources:

Text books:

1. *'Chemistry, Text Book for Class XI'*, National Council of Educational Research and Training, 2006
2. *'Chemistry Text Book for Intermediate First year'*, Board of Intermediate AP
3. *Advanced Chemistry – Volumes 1 and 2* by Philip Matthews, Paperback, Cambridge University Press

Reference Books:

1. *Elements of Physical Chemistry*, 7th Edition by **Peter Atkins** and **Julio de Paula**
2. *Organic chemistry*, 7th Edition by **Morrison Boyd** and **Bhattacharjee**
3. *Chemistry-The central science*, 13th edition, by **Theodore L. Brown**
4. *Organic chemistry*, 3rd Edition by **Janice Gorzynski Smith**
5. *Chemistry: Principles and reactions*, 7th Edition by **Masterton, Hurley and Neth**

Web resources:

1. RGUKT course content
2. Swayam *Chemistry*, <https://swayam.gov.in/chemistry/c/4/science>

Course outcomes: At the end of the course, the student will be able to

CO 1	Calculate the enthalpy of reactions, Gibb's free energy and determine spontaneity of reaction
CO 2	To know the Le Chatelier's principle and its industrial application
CO 3	Calculating the pH, buffer capacity of buffers and solubility product
CO 4	Give the systematic nomenclature of organic compounds
CO 5	Preparation and properties of alkanes, alkenes and, alkynes
CO 6	To know the preparation and properties of benzene & aromatic compounds

Assessment Method

Course Nature	Theory		
Assessment Tool	Monthly tests	End Semester Test	Total
Weightage (%)	40%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY1210	CHEMISTRY PRACTICALS-II	PUC1-SEM2	0 – 0 – 2	1

Course Learning Objectives:

1. To learn how to determine the pH of various unknown sample solutions.
2. To learn how to determine the concentration of a sample by titrimetric methods

Practical Syllabus

1. Determination of pH of some solutions obtained from fruit juices, solutions of known and varied concentrations of acids, bases and salts using pH paper or universal indicator.
2. Comparing the pH of solutions of strong and weak acid of same concentration.
3. Determination of strength of a given solution of sodium hydroxide by titrating it against standard solution of oxalic acid.
4. Determination of strength of a given solution of strong acid ($\text{HCl}/\text{H}_2\text{SO}_4$) by titrating it against standard sodium carbonate and NaOH solution.
5. Determination of concentration of KMnO_4 solution by titrating it against a standard solution of
 - (i) Oxalic acid
 - (ii) Ferrous ammonium sulphate

References:

Text books:

1. *Vogel's Quantitative Chemical Analysis*, SIXTH EDITION.
2. *Vogel's Qualitative Chemical Analysis*, SIXTH EDITION

Course Outcomes:

At the end of the course, the student will be able to estimate the strength of given solution and express in various units.

Assessment Method

Course Nature		Practical (Lab courses only)		
Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

PUC – II

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY2101	CHEMISTRY - III	PUC	4 – 2 – 0	4

Course Learning Objectives:

1. To learn the fundamentals of solids, establish relation between the structure and property of materials
2. To know the laws of electrolysis, application of Nernst equations in various aspects of electrochemistry.
3. To learn the rate of a reaction, molecularity and order of a reaction and concept of activation energy
4. To learn the preparation and properties of alkyl halides and aromatic halides.
5. To know the methods of preparation, properties of alcohols and phenols.
6. To know the general methods of preparation and properties of s-block elements, and group 13, 14 elements

PUC II Semester I

UNIT-1: Solid State

(10 Hours)

General characteristics of solid state, Amorphous and crystalline solids, Classification of crystalline solids, Crystal lattices and unit cells. Bravais lattices, primitive and centred unit cells, Number of atoms in a unit cell (primitive, body centred (CsCl) and face centred cubic unit cell (NaCl)), Close packed structures: Close packing in one dimension, in two dimensions and in three dimensions- tetrahedral and octahedral voids- formula of a compound. Calculations involving unit cell dimensions, density of the unit cell and packing fraction. X-ray analysis of solids –Braggs' equation, Point defects.

UNIT-2:Electrochemistry

(10 Hours)

Electrolytes, non-electrolytes, electrolysis - Faraday's laws of electrolysis and application – conductance in electrolytic solutions – Kohlraush's law and its applications, EMF of the cell Electrochemical cell [galvanic cell], Nernst equation, Type of cells (primary, secondary and fuel cells) – corrosion, rusting of iron, preventing methods of corrosion.

UNIT-3:Chemical Kinetics

(10 hours)

Concept of reaction rate, rate law, units of rate and rate constant – Factors affecting rate of reaction, law of mass action – order and molecularity of a reaction, differential and integrated

rate equations and half-life for zero and first order. Methods of determining reaction order (initial rate method and half-life method), collision theory: concept of activation energy, Arrhenius equation.

UNIT-4: Haloalkanes and haloarenes (08 Hours)

Haloalkanes and Haloarenes: Introduction, nomenclature, preparation, physical and chemical properties of alkyl halides (substitution and elimination only) & uses of ethyl chloride. Mechanism of substitution reaction (S_N^1 & S_N^2), preparation and properties of haloarenes.

UNIT-5: Alcohols, phenols and ethers (08 Hours)

Alcohols & Phenols: Nomenclature, classification of alcohols, preparation, physical and chemical properties of alcohols (ethanol), mechanism of dehydration, distinguishing primary, secondary and tertiary alcohols using Lucas and Victor Mayer's test.

Phenols-nomenclature, preparation, properties and uses.

Ethers-classification, nomenclature, Williamson synthesis of ether, reaction of ethers with strong acids.

UNIT-6: s-block and some p-block elements (12 Hours)

Group 1 and Group 2 elements:

General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens; uses.

Preparation and Properties of sodium hydroxide, biological importance of sodium and potassium, biological importance of Mg and Ca.

General Introduction to *p*-Block Elements

Group 13 elements: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the group; preparation, properties, and structure of diborane.

Group 14 elements: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviour of first element. Carbon - catenation, allotropic forms [diamond, graphite, C_{60} , graphene, amorphous carbon]. Types of silicates.

Learning Resources:

Text books:

1. 'Chemistry, Text Book for Class XII', National Council of Educational Research and Training, 2006
2. 'Chemistry Text Book for Intermediate second year', Board of Intermediate AP
3. *Advanced Chemistry – Volumes 1 and 2* by Philip Matthews, Paperback, Cambridge University Press.

Reference Books:

1. *Elements of Physical Chemistry*, 7th Edition by **Peter Atkins** and **Julio de Paula**
2. *Organic chemistry*, 7th Edition by **Morrison Boyd** and **Bhattacharjee**
3. *Chemistry-The central science*, 13th edition, by **Theodore L. Brown**
4. *Organic chemistry*, 3rd Edition by **Janice Gorzynski Smith**
5. *Chemistry: Principles and reactions*, 7th Edition by **Masterton, Hurley and Neth**

Web resources:

1. RGUKT course content.
2. Swayam, *Chemistry*, <https://swayam.gov.in/chemistry/c/4/science>

Course outcomes: At the end of the course, the student will be able to

CO 1	Calculate the crystal parameters establish the relation between the structure and properties of material
CO 2	Estimate the cell potentials of a given cell notation
CO 3	Determine the order of reaction, activation energy and understanding catalysis
CO 4	Predict the chemical reactivity of alkyl halides
CO 5	Predict the chemical reactivity of alcohols and phenols
CO 6	Understand the preparation and properties of s-block, and group 13, 14 elements.

Assessment Method

Course Nature	Theory		
Assessment Tool	Monthly tests	End Semester Test	Total
Weightage (%)	40%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY2110	CHEMISTRY PRACTICALS-III	PUC2 SEM1	0 – 0 – 2	1

Course Learning Objectives:

To identify the cation and anion present in a given simple salt

Practical Syllabus

Qualitative Analysis

Determination of one anion and one cation in a given salt [5 salts]

Cations - Pb^{2+} , Cu^{2+} , Al^{3+} , Fe^{3+} , Zn^{2+} , Ni^{2+} , Ca^{2+} , Ba^{2+} , Mg^{2+} , NH_4^+ .

Anions - CO_3^{2-} , S^{2-} , SO_4^{2-} , NO_3^- , NO_2^- , Cl^- , Br^- , I^- , PO_4^{3-} , $\text{C}_2\text{O}_4^{2-}$, CH_3COO^- .

References:

Text books:

1. *Vogel's Quantitative Chemical Analysis*, SIXTH EDITION.
2. *Vogel's Qualitative Chemical Analysis*, SIXTH EDITION

Course Outcomes:

At the end of the course, the student will be able to identify the cations and anions present in the given inorganic salt.

Assessment Method

Course Nature		Practical (Lab courses only)		
Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY2201	CHEMISTRY - IV	PUC	4 – 2 – 0	4

Course Learning Objectives:

1. To know the methods of preparation, properties of aldehydes and ketones.
2. To predict the reactivity of nitrogen containing organic compounds and carboxylic acids.
3. To learn the fundamentals of metallurgical processes in extraction of metal from ore samples
4. To know the types of adsorption, types of colloids and their application in industry.
5. To know the physical trends in transition elements, theories of co-ordination chemistry and isomerism.
6. To know the fundamentals of polymerization with an emphasis on some selected polymers.

PUC II Semester II

UNIT-1: Aldehydes and ketones

(12 Hours)

Nomenclature of carbonyl compounds – Preparation of carbonyl compounds from alkenes, alcohols, nitriles and acid chlorides. Chemical properties of carbonyl compounds– Nucleophilic addition reactions with HCN, NaHSO₃, alcohol and RMgX. Mechanism of nucleophilic addition, Condensation reactions with amine derivatives, Oxidation reactions for distinguishing aldehydes and ketones (Tollen's and Fehling's test), Haloform reaction, Reduction of aldehydes and ketones. Reactivity of α -hydrogens in aldehydes (Aldol condensation, crossed aldol and Cannizaro reaction only).

UNIT-2: Carboxylic acids and Amines

(12 Hours)

Carboxylic acids: Nomenclature, Preparation of carboxylic acids from alcohols, nitriles and Grignard reagent. Physical properties, chemical properties of carboxylic acids: Acidity of carboxylic acids, Esterification (including mechanism), Reaction with thionyl chloride (SOCl₂), P₂O₅, decarboxylation and reduction reactions. Hell-Volhard-Zelinsky reaction (α -halogenation of carboxylic acids).

Amines: Nomenclature, Preparation of amines from alkyl halides, nitro compounds, and nitriles. Hoffmann bromamide degradation and Gabriel Phthalimide synthesis. Physical and chemical properties of amines-basicity of amines, alkylation, acylation, diazotization, carbylamines reaction. Distinguishing amines using Hinsberg reagent (PhSO₂Cl). Aniline-preparation, and properties.

UNIT-3: d-block elements and coordination compounds (10 Hours)

Introduction to d-block elements, electronic configuration, general trends in properties of first row transition metals-electronic configuration, color, magnetic properties, alloys and complex formation.

Coordination compounds: Introduction, nomenclature of coordination compounds – Theories of coordination compounds (Werner's theory, Sidgwick's and Valence bond theory only). Isomerism (geometrical and optical isomerism).

UNIT-4: Surface chemistry (10 Hours)

Adsorption and absorption: Types and characteristics of physisorption and chemisorption. Factors affecting the adsorption of a gas on solid. Freundlich and Langmuir adsorption isotherms. Applications of adsorption. Colloids- Classification (Based on different criteria) - multi molecular, macromolecular and associated colloids, properties of colloidal solutions: Tyndal effect, Brownian movement, electrophoresis, Emulsions and cleansing action of soap.

UNIT-5: Metallurgy (08 Hours)

Occurrence of metals, Concentration of ores - levigation, magnetic separation, froth floatation, leaching, Extraction of crude metal from concentrated ore, conversion to oxide, reduction of oxide to the metal. Extraction of iron, copper and aluminum from their ores, uses of iron, copper and aluminum.

UNIT-6: Polymers (08 Hours)

Classification of Polymers -Classification based on source, structure, mode of polymerization, molecular forces and growth polymerization. Types of polymerization reactions- addition or chain growth polymerization, ionic and free radical polymerization mechanism. Natural rubber, vulcanisation of rubber, Synthetic rubbers. Preparation of neoprene and buna-N. Molecular mass of polymers. Commercial importance of polymers like polypropene, polystyrene, polyvinyl chloride (PVC), urea-formaldehyde resin, glyptal, bakelite- their monomers, structures and uses.

Learning Resources:

Text books:

1. '*Chemistry, Text Book for Class XII*', National Council of Educational Research and Training, 2006
2. '*Chemistry Text Book for Intermediate second year*', Board of Intermediate AP

Reference Books:

1. *Elements of Physical Chemistry*, 7th Edition by **Peter Atkins** and **Julio de Paula**
2. *Organic chemistry*, 7th Edition by **Morrison Boyd** and **Bhattacharjee**
3. *Concise Inorganic Chemistry*, 5th Edition by **J.D. Lee**
4. *Organic chemistry*, 3rd Edition by **Janice Gorzynski Smith**
5. *Polymer science*, by **Vasant R. Gowariker**, **N. V. Viswanathan**

Web resources:

1. RGUKT course content.
2. Swayam, *Chemistry*, <https://swayam.gov.in/chemistry/c/4/science>

Course outcomes: At the end of the course, the student will be able to

CO 1	Compare the reactivity's of aldehydes and ketones
CO 2	Predict the acidity of carboxylic acids and basicity of amines
CO 3	Explain the method of extraction of metals from ore samples
CO 4	Calculation of adsorption isotherms, properties of colloidal solutions etc.
CO 5	To Predict the physical trends of Transition elements and idea about co-ordination chemistry
CO 6	To know the preparation methods of polymers, structure and industrial applications of some polymers.

Assessment Method

Course Nature	Theory		
Assessment Tool	Monthly tests	End Semester Test	Total
Weightage (%)	40%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	Course Category	L – T – P	Credits
20PCY2202	CHEMISTRY PRACTICALS-IV	PUC2-SEM2	0 – 0 – 2	1

Course Learning Objectives:

1. To identify and confirm the functional group present in a given organic compound
2. To learn how to prepare a few organic compounds

Practical Syllabus

1. Test for the Functional Groups Present in Organic Compounds (Periods 10)

Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (primary), and carbohydrate groups.

2. Preparation of Organic Compounds (any one of the following compounds)

- (a) Acetanilide
- (b) Aniline yellow or 2-Naphthol aniline dye

References:

Text books:

3. *Vogel's Quantitative Chemical Analysis*, SIXTH EDITION.
4. *Vogel's Qualitative Chemical Analysis*, SIXTH EDITION

Course Outcomes:

At the end of the course, the student will be able to

1. Identify and confirm the presence of few organic functional groups
2. Able to prepare some organic compounds

Assessment Method

Course Nature		Practical (Lab courses only)		
Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

Engineering Chemistry

COURSE STRUCTURE

THEORY

Course code	Course Name	L	T	P	C
20CY1101	Physical and Organic Chemistry	3	0	0	3
20CY1102	Engineering Chemistry for Civil Engineering	3	0	0	3
20CY1103	Engineering Chemistry for Mechanical Engineering	3	0	0	3
20CY1204	Engineering Chemistry for Metallurgical & Materials Engineering	3	0	0	3

PRACTICALS

20CY1181	Physical and Organic Chemistry Practicals	0	0	3	1.5
20CY1182	Engineering Chemistry Practicals for Civil Engineering	0	0	3	1.5
20BS1183	Engineering Physics and Chemistry Laboratory	0	0	3	1.5
20CY1284	Engineering Chemistry Practicals for Metallurgical & Material Engineering	0	0	3	1.5

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course Name	L	T	P	C
20CY1101	Physical and Organic Chemistry	3	0	0	3

Course Learning Objectives:

1. To acquire knowledge about distribution law importance, its applications and basic concepts in understanding phase rule.
2. To gain the knowledge on rate of reaction and factors affecting rate of reactions
3. To acquire basic knowledge on electrochemical cells and to gain knowledge on types of water and problems
4. To characterize chemical compound by using analytical techniques
5. To get to know the different types of reactions and its intermediates
6. To understand the types of drugs and its properties.

Syllabus

UNIT-I: Distribution Law and Phase Rule

(7 Hours)

Distribution Law – Nernst Distribution Law – Distribution Coefficient – Explanation and Limitations of Distribution Law - Modification of Distribution Law – Determination of Equilibrium Constant from Distribution Coefficient – Applications of Distribution Law- Phase Rule – Terms involved in Phase Rule – Types of Liquids – Derivation of Phase Rule – Phase Diagrams of One Component System (Water, CO₂ and Sulphur systems), Two Component System – Eutectic Point (Lead Silver System. Applications of Phase Rule

UNIT-II: Chemical Kinetics

(8 Hours)

Introduction to Chemical Kinetics – Theories of Reaction Rates – Collision Theory – Modified Collision Theory – Arrhenius Theory – Brief note on Absolute Reaction Rate Theory (Transition State Theory) – Reaction between Ions – Influence of Solvent (Double Sphere Activated Complex and Single Sphere Activated Complex) – Lindemann's theory of unimolecular reactions – Influence of Ionic Strength on the Rate of the Reactions – Steady State Approximation in Chain Reactions – Hydrogen and Bromine, Hydrogen and Oxygen (Steady State Treatment) – Explosion Limits.

UNIT III: Electrochemistry & Water Technology

(7 Hours)

Electrochemistry: Overview of Fundamentals of Electrochemistry - Concentration Cells – Batteries: Dry Cell - Ni-Cd cells - Ni-Metal hydride cells- Li cells - Zinc – air cells. Fuel cells: - Hydrogen Oxygen fuel cells – Methanol Oxygen fuel cells.

Water Technology: Hard water – Reasons for hardness – units of hardness - Boiler troubles – Priming and Foaming, Scale formation, Boiler corrosion, Caustic embrittlement - Internal treatments - Softening of Hard water : Lime – Soda process, Zeolite process and numerical problems based on these processes and Ion Exchange.

UNIT-IV: Analytical Techniques

(8 Hours)

Absorption Spectroscopy: Beer-Lambert's law and its limitations, transmittance, Absorbance, and molar absorptivity; Application of Beers-Lamberts law for simultaneous quantitative analysis of Cr in $K_2Cr_2O_7$, Mn in $KMnO_4$

Separation Techniques: Solvent extraction: Principle and process, Batch extraction, Continuous extraction and counter current extraction, Industrial Applications.

Chromatography: Classification of chromatography methods, Principles and Applications of – Paper Chromatography, Thin Layer Chromatography (TLC), Column Chromatography, Ion-exchange Chromatography, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Supercritical Fluid Chromatography.

UNIT- V: Organic Chemistry

(8 Hours)

Types of reactions-Reaction intermediates – Carbocation, carbanion, free radical, and carbene. Reaction mechanisms - aldol, Perkin, Cannizzaro's reaction, Beckmann rearrangement, Benzoin condensation. Allylic halogenation using N-bromo succinamide (NBS), Heterocyclic compounds – Preparation, properties, and applications of pyrrole, furan, thiophene, and pyridine.

UNIT- VI: Pharmaceutical Chemistry (7Hours)

Drug discovery and development process, Sequence of events after drug administration, List of physico-chemical properties related to drug action, Clinical Chemistry and the importance of fundamental chemistry concepts and analytical techniques. Pharmaceuticals – Classification - examples of Antihistamine / Antibacterial / Anti inflammatory/Antifungal drugs - preparation of paracetamol and Aspirin.

Learning resources

Text Books:

1. Peter Atkins, Julia de Paula, *Physical Chemistry*, 9th Edition, Oxford University Press, 2011.
2. Laidler, K. J., *Chemical Kinetics*, 2nd Edition, McGraw-Hill, 1965.
3. Puri, B. R., L. R. Sharma, *Principles of Physical Chemistry*, M. S. Pathama, Vishal Publishing Company, 2008.
4. Jain & Jain, *Engineering Chemistry*, 16th Edition, 2015.
5. Advanced Chemistry – Volumes 1 and 2 by Philip Matthews, Paperback, Cambridge University Press.

Reference Books:

1. L. N. Ferguson, *Text Book of Organic Chemistry*, 2nd Edition, East-West Press, 2009.
2. Shilkha Agarwal, *Engineering Chemistry*, 2nd Edition, 2019
3. Vairam and others, *Engineering Chemistry*, Wiley India Pvt. Ltd., 2014 edition (second)
4. Kapoor, K. L., *A Textbook of Physical Chemistry*, Macmillan, 2000.
5. *Chemical Separation Methods*, John A. Dean, Van Nostrand Reinhold, 1969.
6. Kour, H., Pragati *An Introduction to Chromatography*, Publishers, 2007.
7. M. N., Himalaya Publications, *Separation Methods*, Sastry, 3rd Edition, 2005.
8. Finar, I. L., *Organic Chemistry*, Vol 1, Pearsons, 2002.
9. *Organic Chemistry Concepts and Applications for Medicinal Chemistry*, Joseph E. Rice, Academic Press, 2014, Softcover; ISBN 9780128007396 or eBook; ISBN 9780128008324.
10. David G. Watson. *Pharmaceutical Analysis, A Textbook for Pharmacy Students and Pharmaceutical Chemists*, 3rd Edition, 2012, Elsevier.

Course outcomes: At the end of the course, the student will be able to

CO 1	Determine equilibrium constant from distribution law.
CO 2	Derive rate of reactions based by considering theories of reaction rate, solvent effect, and ionic strength factors.
CO 3	Constructing electrochemical cell and developing different methods for attaining soft water by different treatment procedures.
CO 4	Isolating pure chemical compound and characterizing it based on knowledge on analytical techniques.
CO 5	.To understand the various reaction mechanisms observed in organic compounds

CO 6	To understand the fundamentals of Pharmaceutical and nanomaterials chemistry.
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Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course Name	L	T	P	C
20CY1181	Physical and Organic Chemistry Practicals	0	0	1.5	1.5

Course Learning Objectives:

At the end of this course, the student will be able to

1. To understand the water quality in terms of hardness
2. To know the concentration of unknown acid/base concentration by using titrations methods
3. To study the physical property of chemical substances
4. To study kinetics of reactions
5. To know medicinal compounds preparation

Practical Syllabus

List of Experiments:

1. Determination of temporary and permanent hardness of water using standard EDTA solution.
2. Determination of Iron by a Colorimetric method using thiocyanate as reagent.
3. Preparation of soap by using palm oil.
4. pH-metric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
5. Conductometric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
6. Potentiometric titrations
 - a. strong acid and strong base.
 - b. $K_2Cr_2O_7$ and Mohr's salt.
7. Determination of density and surface tension of liquids against air
8. Determination of viscosities of pure liquids and solutions
9. Determination of Kinetics of the Reduction of Methylene Blue by Ascorbic Acid.
10. Preparation of Organic Medicinal Compounds:
Aspirin/ Azodye /Acetanilide /Thiokol Rubber /Paracetamol
11. Extraction of Caffeine from Tea leaves
12. Adsorption of oxalic acid on Charcoal

Reference Books:

- 1) *Chemistry Practical Manual*, Lorven Publications
- 2) K. Mukkanti (2009) *Practical Engineering Chemistry*, B.S. Publication
- 3) Arthur J. Vogel, *A Textbook of Quantitative Analysis*.
- 4) Dr. Jyotsna Cherukuri *Laboratory Manual of engineering chemistry-II*, VGS Techno Series, 2012.

Course outcomes: At the end of the course, the student will be able to

CO 1	Ability to judge water quality of different places in terms of hardness.
CO 2	Estimate unknown concentration of acid/base by using pH-metric, potentiometric and conductometric titration methods.
CO 3	Derive the physical characterization like surface tension and viscosity of chemical substances
CO 4	Determine rate of reactions.
CO 5	Synthesizing medicinal compounds

Course Nature		Practical		
Assessment Method				
Assessment Tool (In semester)	Experiments related	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	20%	10%	10%	40%
Assessment Tool (End semester)	Procedure/Description of the experiment with relevant information and Discussion on Results	Results	Viva-Voce	
Weightage (%)	30%	10%	20%	60%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
20CY1102	Engineering Chemistry for Civil Engineering	3	0	0	3

Course Learning Objectives:

1. To introduce topics about distribution law phase rule, phase diagram
2. To gain the knowledge on fuels, its analysis and determining physical property of lubricants.
3. To understand potential generation from chemical reaction and corrosion methods
4. To characterize of chemical compounds by using analytical Techniques.
5. To gain knowledge on types of water and problems and solution associated with water.
6. To understand industrial preparation of commercial materials

Syllabus

UNIT-I: Distribution Law and Phase Rule

(7 Hours)

Distribution Law – Nernst Distribution Law – Distribution Coefficient – Explanation and Limitations of Distribution Law - Modification of Distribution Law – Determination of Equilibrium Constant from Distribution Coefficient – Applications of Distribution Law
Phase Rule – Terms involved in Phase Rule – Types of Liquids – Derivation of Phase Rule – Phase Diagrams of One Component System (Water, CO₂ and Sulphur systems), Two Component System – Eutectic Point (Lead Silver System) and three component system. Applications of Phase Rule

UNIT- II: Fuels & Lubricants

(7 Hours)

Fuels - Classification, examples, relative merits, types of coal, determination of calorific value of solid fuels, Bomb calorimeter, theoretical oxygen requirement for combustion, proximate & ultimate analysis of coal, manufacture of metallurgical coke, flue gas analysis, problems. Lubricants - Definition, theories of lubrication, characteristics of lubricants, viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point, additives to lubricants, Solid lubricants.

UNIT- III: Electrochemistry and corrosion

(7 Hours)

Overview of Fundamentals of Electrochemistry - Concentration Cells – Batteries: Dry Cell - Ni-Cd cells - Ni-Metal hydride cells- Li cells - Zinc – air cells.

Corrosion :- Definition – Theories of Corrosion (chemical & electrochemical) – Formation of galvanic cells by different metals, by concentration cells, by differential aeration and waterline corrosion – Passivity of metals – Pitting corrosion - Galvanic series – Factors which influence the rate of corrosion - Protection from corrosion – Design and material selection – Cathodic protection - Protective coatings: – Surface preparation – Metallic (cathodic and anodic) coatings
Fuel cells: - Hydrogen Oxygen fuel cells – Methanol Oxygen fuel cells

UNIT-IV: Analytical Techniques

(7 Hours)

Absorption Spectroscopy: Beer-Lambert's law and its limitations, transmittance, Absorbance, and molar absorptivity; Application of Beers-Lamberts law for simultaneous quantitative analysis of Cr in $K_2Cr_2O_7$, Mn in $KMnO_4$

Separation Techniques: Solvent extraction: Principle and process, Batch extraction, Continuous extraction and counter current extraction, Industrial Applications.

Chromatography: Classification of chromatography methods, Principles and Applications of – Paper Chromatography, Thin Layer Chromatography (TLC), Column Chromatography, Ion-exchange Chromatography, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Supercritical Fluid Chromatography.

UNIT- V: Water Technology

(7 Hours)

Hard water:- Reasons for hardness – units of hardness - Boiler troubles – Priming and Foaming, Scale formation, Boiler corrosion, Caustic embrittlement - Internal treatments - Softening of Hard water : Lime – Soda process, Zeolite process and numerical problems based on these processes and Ion Exchange process - Water for drinking purposes- Purification – Sterilization and disinfection : Chlorination, Break point chlorination and other methods – Reverse Osmosis and Electro Dialysis.

UNIT- VI: Industrial Chemistry & Introduction to Nanotechnology

(10 Hours)

Industrial Chemistry: Glass, Ceramics, Cement – Classification, ingredients and their role, Manufacture of cement and the setting process, quick setting cements

Alloys: Classification of alloys, Ferrous and Non-Ferrous alloys, Specific properties of elements in alloys.

Introduction to Nanotechnology: Introduction and classification of nanomaterials (0D, 1D, 2D, and 3D nanostructures) – Overview on synthesis of nanomaterials (Bottom-up and top-down methods) – chemical reduction, sol-gel, hydrothermal, solvothermal, ball-milling. Applications of nanotechnology in catalysis and surface coatings.

Learning resources

Text Books:

1. Physical Chemistry, Peter Atkins, Julia de Paula, 9th Edition, Oxford University Press, 2011.

2. Chemical Kinetics, Laidler, K. J., 2nd Edition, McGraw-Hill, 1965.
3. Principles of Physical Chemistry, Puri, B. R., L. R. Sharma, M. S. Pathama, Vishal Publishing Company, 2008.
4. Jain & Jain, *Engineering Chemistry*, 16th Edition, 2015

Reference Books:

1. L. N. Ferguson, Text Book of Organic Chemistry, 2nd Edition, East-West Press, 2009.
2. Vairam, *Engineering Chemistry* of Wiley India Pvt. Ltd., edition (second) 2014
3. Shilkha Agarwal, *Engineering Chemistry*, 2nd Edition, 2019
4. Kapoor, K. L., *A Textbook of Physical Chemistry*, Macmillan 2000.
5. John A. Dean, Van Nostrand Reinhold, *Chemical Separation Methods*, 1969.
6. Pragati *An Introduction to Chromatography*, Publishers, 2007.
7. Sastry, M. N., *Separation Methods*, Himalaya Publications, 3rd Edition, 2005.
8. Finar, I. L., *Organic Chemistry*, Vol 1, Pearsons, 2002

Web Resoureces:

NPTTEL, *Chemistry*, <http://www.nptelvideos.com/chemistry/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Identifying factors effecting solubility and extraction method from distribution law. Phase rule enable to classify equilibrium states in terms of phases, components and degrees of freedom.
CO 2	Analyze fuel property and determine efficiency of different fuels.
	Develop ability to construct electrochemical cell and evaluate methods to prevent corrosion
CO 4	Isolation and characterize of chemical compound by chromatographic techniques.
CO 5	To gain knowledge about water problems and solution associated with water.
CO 6	To analyze Glass, ceramics, cement properties and to categorize different types of alloys

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course Name	L	T	P	C
20CY1182	Engineering Chemistry practicals for Civil Engineering	0	0	3	1.5

Course Learning Objectives:

At the end of this course, the student will be able to

1. To understand the water quality in terms of hardness
2. To know the concentration of acid/base concentration by using titrations methods
3. To study the physical property of chemical substances
4. Estimation metal concentration in alloys and cement
5. To gain the knowledge on fuels, its analysis and determining physical property of lubricants.

Practical Syllabus

List of Experiments:

1. Determination of temporary and permanent hardness of water using standard EDTA solution.
2. Determination of percentage of Iron in Cement sample by colorimetry.
3. Determination of percentage of copper in brass
4. Estimation of Calcium in port land Cement
5. pH-metric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
6. Conductometric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
7. Potentiometric titrations
 - a. strong acid and strong base.
 - b. $K_2Cr_2O_7$ and Mohr's salt.
8. Determination of density and surface tension of liquids against air
9. Determination of viscosities of pure liquids and solutions
10. Fuel Characterization:
 - a. Flash point, Fire point
 - b. Ash content
11. Adsorption of oxalic acid on charcoal

Reference Books:

1. *Chemistry Practical Manual*, Lorven Publications
2. K. Mukkanti (2009) *Practical Engineering Chemistry*, B.S. Publication
3. A Textbook of *Quantitative Analysis*, Arthur J. Vogel.
4. Dr. Jyotsna Cherukuris (2012) *Laboratory Manual of engineering chemistry-II*, VGS Techno Series

Course outcomes: At the end of the course, the student will be able to

CO 1	Ability to judge water quality of different places in terms of hardness.
CO 2	Estimate unknown concentration of acid/base by using pH-metric, potentiometric and conductometric titration methods.
CO 3	Derive the physical characterization like surface tension and viscosity of chemical substances
CO 4	Find out concentration in alloys & cement
CO 5	Analyze the physical properties of different fuels

Course Nature		Practical		
Assessment Method				
Assessment Tool (In semester)	Experiments related	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	20%	10%	10%	40%
Assessment Tool (End semester)	Procedure/Description of the experiment with relevant information and Discussion on Results	Results	Viva-Voce	
Weightage (%)	30%	10%	20%	60%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
20CY1103	Engineering Chemistry for Mechanical Engineering	3	0	0	3

Course Learning Objectives:

1. To get knowledge on types of water and problems and solution associated with water.
2. To gain the knowledge on fuels, its analysis and determining physical property of lubricants.
3. To acquire basic knowledge on electrochemical cells, its classification and corrosion factors
4. To know types of polymers and its characterization techniques
5. To understand the extent adsorption and surface coating methods

Syllabus

UNIT- I: Water Technology

(7 Hours)

Hard water:- Reasons for hardness – units of hardness - Boiler troubles – Priming and Foaming, Scale formation, Boiler corrosion, Caustic embrittlement - Internal treatments - Softening of Hard water : Lime – Soda process, Zeolite process and numerical problems based on these processes and Ion Exchange process - Water for drinking purposes- Purification – Sterilization and disinfection : Chlorination, Break point chlorination and other methods – Reverse Osmosis and Electro Dialysis.

UNIT- II: Fuels & Lubricants

(7 Hours)

Fuels - Classification, examples, relative merits, types of coal, determination of calorific value of solid fuels, Bomb calorimeter, theoretical oxygen requirement for combustion, proximate & ultimate analysis of coal, manufacture of metallurgical coke. Lubricants - Definition, theories of lubrication, Solid and liquid lubricants, Grease -characteristics of lubricants, viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point, additives to lubricants, Solid lubricants.

UNIT- III: Electrochemistry and corrosion**(7 Hours)**

Overview of Fundamentals of Electrochemistry - Concentration Cells – Batteries: Dry Cell - Ni-Cd cells - Ni-Metal hydride cells- Li cells - Zinc – air cells.

Corrosion :- Definition – Theories of Corrosion (chemical & electrochemical) – Formation of galvanic cells by different metals, by concentration cells, by differential aeration and waterline corrosion – Passivity of metals – Pitting corrosion - Galvanic series – Factors which influence the rate of corrosion - Protection from corrosion – Design and material selection – Cathodic protection - Protective coatings: – Surface preparation – Metallic (cathodic and anodic) coatings Fuel cells: - Hydrogen Oxygen fuel cells – Methanol Oxygen fuel cells

UNIT- IV Polymer Chemistry**(8 Hours)**

Introduction to polymerization techniques – bulk, solution, suspension, and emulsion polymerization. The visco elasticity of polymer (Glassy state, Visco-elastic state, Visco-fluid state, Solid phase, Liquid phase), glass transition temperature & its effect on polymer. Crystalline and amorphous structure of polymer, Degree of crystallinity, Types of polymer degradation-Chain-end & Random degradation, Thermal Degradation, Mechanical Degradation, Ultrasonic wave Degradation, Photo degradation. Introduction, preparation and applications of bio-degradable polymers (PLA) and conducting polymers (PANI).

UNIT- V Surface Chemistry and Surface Coatings**(9 Hours)**

Adsorption-Types of adsorption-adsorption of gases on solids- adsorption from solutions- Types of isotherms Freundlich adsorption isotherm, Langmuir adsorption isotherm. Industrial applications of adsorption. Surface Coatings Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit VI: Introduction to Nanomaterials and Nanotechnology**(7 Hours)**

Introduction to Nanostructures: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles) Nanowires, Nanobiosensors: Science of Self-assembly - From Natural to Artificial Structures Nanoparticles in Biological Labeling and Cellular Imaging.

Learning Resources:**Text book:**

1. P. C. Jain, Monica Jain, “*Engineering Chemistry*”, Dhanpat Rai Publishing Company, 15th Edition, 2015

2. Shasi Chawla, “*Text Book of Engineering Chemistry*”, Dhanpat Rai Publishing Company, New Delhi, 1st Edition, 2011.
3. Jain & Jain, *Engineering Chemistry*, 16th Edition, 2015

References:

1. Nelson Nemerow *Theories and Practices of Industrial waste treatment*.
2. *Engineering Chemistry* by Shikha Agarwal; Cambridge University Press, 2015 Edition.
3. Pahari A., Chauhan B., “*Engineering Chemistry*”, Firewall Media, New Delhi, 2012.
4. Sivasankar B., “*Engineering Chemistry*”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
5. AshimaSrivastava. Janhavi N N, “*Concepts of Engineering Chemistry*”, ACME Learning Private Limited., New Delhi., 2010.
6. Vairam S., Kalyani P., Suba Ramesh., “*Engineering Chemistry*”, Wiley India Pvt Ltd., New Delhi., 2011
7. Peter Atkins, Julia de Paula, *Physical Chemistry*, 9th Edition, Oxford University Press, 2011.
8. L. N. Ferguson, *Text Book of Organic Chemistry*, 2nd Edition, East-West Press, 2009.
9. E. Stocchi: *Industrial Chemistry*, Vol-I, , Ellis Horwood Ltd. UK.
10. Vasant R. Gowariker, *Polymer Science*, New Age International, 1986, ISBN 0852263074, 9780852263075
11. Fred W. Billmeyer, John Wiley & Sons, 3rd Edition, ISBN: 978-0-471-03196-3

Web resources:

1. RGUKT course content
2. Swayam, *Chemistry*, <https://swayam.gov.in/chemistry/c/4/science>

Course outcomes: At the end of the course, the student will be able to

CO 1	Develop different methods for attaining soft water by different treatment procedures.
CO 2	Analyze fuel property and determine efficiency of different fuels.
CO 3	Constructing electrochemical cell and take measures for prevention/protection of/from corrosion.
CO 4	Distinguish different types of polymers and analyze polymer rheology.
CO 5	Derive the methods for the adsorption isotherm and framing formulations of surface coatings.
CO 6	Understanding the fundamentals of nanomaterials and nanotechnology

Course Nature	Theory
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Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
20BS1183	Engineering Physics and Chemistry Laboratory	0	0	3	1.5

Course Objectives:

1. To understand the water quality in terms of hardness
2. To know the metal percentage present in alloys.
3. To study the physical property of chemical compounds
4. To identify efficiency of fuels
5. To understand catalytic activity from Adsorption Isotherm

List of experiments:

1. Determination of temporary and permanent hardness of water using standard EDTA solution.
2. Determination of percentage of copper in brass
3. Determination of calorific value of a given substance using Bomb calorimeter.
4. Determination of density and surface tension of liquids against air
5. Determination of viscosities of liquids.
6. Determine the Flash point and Fire point of chemical compounds
7. Adsorption of oxalic acid by Charcoal

Reference Books:

- 1) *Chemistry Practical Manual*, Lorven Publications
- 2) K. Mukkanti (2009) *Practical Engineering Chemistry*, B.S. Publication
- 3) Arthur J. Vogel, *A Textbook of Quantitative Analysis*.
- 4) Dr. Jyotsna Cherukuris *Laboratory Manual of engineering chemistry-II*, VGS Techno Series, 2012.

Course outcomes: At the end of the course, the student will be able to

1	Ability to judge water quality of different places in terms of hardness.
2	Estimate metal percentage in brass
3	Derive the physical characterization like size, surface tension and viscosity of chemical compounds
4	Analyze the physical properties of different fuels
5	Derive adsorption isotherms and characterize catalyzing activity

Course Nature		Practical		
Assessment Method				
Assessment Tool (In semester)	Experiments related	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	20%	10%	10%	40%
Assessment Tool (End semester)	Procedure/Description of the experiment with relevant information and Discussion on Results	Results	Viva-Voce	
Weightage (%)	30%	10%	20%	60%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
20CY1Y04	Engineering Chemistry for Metallurgical & Materials Engineering	3	0	0	3

Course Learning Objectives:

1. To get knowledge on types of water and problems and solution associated with water.
2. To gain the knowledge on fuels, its analysis and determining physical property of lubricants.
3. To understand factors involved in the organic reaction to get products
4. To know types of polymers and its characterization techniques
5. To gain knowledge on adsorption and its application
6. To know the characterization of chemical compounds by using spectroscopic methods

Syllabus

UNIT- I : Water Technology

(7 Hours)

Hard water:- Reasons for hardness – units of hardness - Boiler troubles – Priming and Foaming, Scale formation, Boiler corrosion, Caustic embrittlement - Internal treatments - Softening of Hard water : Lime – Soda process, Zeolite process and numerical problems based on these processes and Ion Exchange process - Water for drinking purposes- Purification – Sterilization and disinfection : Chlorination, Break point chlorination and other methods – Reverse Osmosis and Electro Dialysis.

UNIT- II: Fuels & Lubricants

(7 Hours)

Fuels - Classification, examples, relative merits, types of coal, determination of calorific value of solid fuels, Bomb calorimeter, theoretical oxygen requirement for combustion, proximate & ultimate analysis of coal, manufacture of metallurgical coke, flue gas analysis, problems. Lubricants - Definition, theories of lubrication, characteristics of lubricants, viscosity, viscosity index, oiliness, pour point, cloud point, flash point, fire point, additives to lubricants, Solid lubricants.

UNIT- III Organometallic Chemistry**(7 Hours)**

Introduction to organometallic chemistry, Structure and bonding - fluxional molecules, Ligands, Preparation and reactivity of RMgX , Ferrocene, Gilman reagent. Applications of organometallic complexes in organic synthesis (RMgX) and industrial catalysis (Organopalladium reagents), medical applications of Cis-Platin, Ligand to Metal and Metal to ligand Charge Transfer process and its analytical applications.

UNIT-IV: Analytical Techniques**(9 Hours)**

Absorption Spectroscopy: Beer-Lambert's law and its limitations, transmittance, Absorbance, and molar absorptivity; Application of Beers-Lamberts law for simultaneous quantitative analysis of Cr in $\text{K}_2\text{Cr}_2\text{O}_7$, Mn in KMnO_4

Infrared Spectroscopy – Introduction, Principle, Modes of vibrations, Signal characteristics-Wave number.

Powder X-Ray Diffraction – Braggs' law and Scherrer's Equation, Electron Microscopy – Electron Specimen Interactions – Principle and applications of SEM, TEM

UNIT V Surface Chemistry and Catalysis**(7 Hours)**

Adsorption-Types of adsorption-adsorption of gases on solids- adsorption from solutions- Types of isotherms Freundlich adsorption isotherm, Langmuir adsorption isotherm. Industrial applications of adsorption. Catalysis: Characteristics and types of catalysts-homogeneous and heterogeneous, auto catalysis, Industrial applications of catalysts.

Unit VI: Introduction to Nanomaterials and Nanotechnology**(8 Hours)**

Nanomaterial: Introduction to Nanostructures: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles) Nanowires, Introduction to metal based nanostructures, Nanobiosensors: Science of Self-assembly - From Natural to Artificial Structures Nanoparticles in Biological Labeling and Cellular Imaging.

Learning Resources:**Text Books:**

- 1) P. C. Jain, Monica Jain, “*Engineering Chemistry*”, Dhanpat Rai Publishing Company, 15th Edition, 2015
- 2) Shasi Chawla, “*Text Book of Engineering Chemistry*”, Dhantpat Rai Publishing Company, New Delhi, 1st Edition, 2011.
- 3) Jain & Jain, *Engineering Chemistry*, 16th Edition, 2015
- 4) *Advanced Chemistry – Volumes 1 and 2* by Philip Matthews, Paperback, Cambridge University Press

References:

- 1) *Theories and Practices of Industrial waste treatment*- Nelson Nemerow.
- 2) *Engineering Chemistry* by Shikha Agarwal; Cambridge University Press, 2015 edition.
- 3) Pahari A., Chauhan B., “*Engineering Chemistry*”, Firewall Media, New Delhi, 2012.
- 4) AshimaSrivastava. Janhavi N N, “*Concepts of Engineering Chemistry*”, ACME Learning Private Limited., New Delhi., 2010.
- 5) Vairam S., Kalyani P., Suba Ramesh., “*Engineering Chemistry*”, Wiley India Pvt Ltd., New Delhi., 2011
- 6) *Physical Chemistry*, Peter Atkins, Julia de Paula, 9th Edition, Oxford University Press, 2011.
- 7) *Organotransition Metal Chemistry – From Bonding to Catalysis*, John F. Hartwig, ISBN-13: 978-1891389535

Course outcomes: At the end of the course, the student will be able to

CO 1	Develop different methods for attaining soft water by different treatment procedures.
CO 2	Analyze fuel property and determine efficiency of different fuels.
CO 3	Derive the factors involved in reaction to get products
CO 4	Distinguish different types of polymers and analyze their property.
CO 5	Derive adsorption isotherms and characterize catalyzing activity
CO 6	Characterize of chemical compound by using UV-Vis, IR, XRD, and EM

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
CY1Y84	Engineering Chemistry Practicals for Metallurgical & Materials Engineering	0	0	3	1.5

Course Learning Objectives:

1. To understand the water quality in terms of hardness
2. To know the metal percentage present in alloys.
3. To prepare chemical substances like soap, sulphur based polymer
4. To study the physical property of chemical compounds
5. To derive adsorption isotherm
6. To identify properties of different fuels.

Practical Syllabus

List of Experiments:

1. Determination of temporary and permanent hardness of water using standard EDTA solution.
2. Determination of percentage of copper in brass
3. pH-metric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
4. Conductometric titrations
 - a. strong acid and strong base.
 - b. strong acid and weak base.
5. Potentiometric titrations
 - a. strong acid and strong base.
 - b. $K_2Cr_2O_7$ and Mohr's salt.
6. determination of copper by Electro-gravimetric analysis.
7. Determination of Iron by a Jobs method
8. Determination of density and surface tension of liquids against air
9. Determination of viscosities of pure liquids and solutions
10. Adsorption of oxalic acid by Charcoal
11. Fuel Characterization:
 - a. Flash point, Fire point

b. Ash content

Learning Resources:

Text Books:

1. *Chemistry Practical Manual*, Lorven Publications
2. K. Mukkanti (2009) *Practical Engineering Chemistry*, B.S. Publication
3. Arthur J. Vogel, *A Textbook of Quantitative Analysis*.
4. Dr. Jyotsna Cherukuri *Laboratory Manual of engineering chemistry-II*, VGS Techno Series, 2012.

Course outcomes: At the end of the course, the student will be able to

CO 1	Ability to judge water quality of different places in terms of hardness.
CO 2	Estimate metal percentage in brass
CO 3	Handle chemical compounds during synthesis of chemical compounds.
CO 4	Derive the physical characterization like size, surface tension and viscosity of chemical substances
CO 5	Derive adsorption isotherms and characterize catalyzing activity
CO 6	Analyze the physical properties of different fuels

Course Nature		Practical		
Assessment Method				
Assessment Tool (In semester)	Experiments related	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	20%	10%	10%	40%
Assessment Tool (End semester)	Procedure/Description of the experiment with relevant information and Discussion on Results	Results	Viva-Voce	
Weightage (%)	30%	10%	20%	60%

References:

MINOR IN CHEMISTRY

COURSE STRUCTURE

Course Code	Course Category	Name of the Minor/Elective	L-T-P	Credits
CYM101	PCC	Basic Analytical Chemistry	3-1-0	4
CYM102	PCC	Chemistry lab for Minors	0-0-3	3
CYM203	PCC	Industrial Inorganic Chemistry	3-1-0	4
CYM204	PCC	Electrochemistry, Corrosion and Fuel Chemistry	3-0-0	3
CYM105	PCC	Chemical separation using chromatography	3-0-0	3
CYM106	PEC	Nanomaterials	3-0-0	3
CYM107	PEC	Catalysis	3-0-0	3
CYM108	PEC	Food chemistry	3-0-0	3
CYM109	PEC	Introduction to Quantum Chemistry	3-0-0	3
CYM110	PEC	Electroanalytical and electrochemical methods	3-0-0	3
CYM211	PEC	Chemistry of functional materials	3-0-0	3
CYM212	PEC	Environmental and Green Chemistry	3-0-0	3
CYM213	PEC	Computational Methods in Chemistry	3-0-0	3
CYM214	PEC	Electrochemical Energy Systems	3-0-0	3
CYM215	PEC	Molecular Spectroscopy	3-0-0	3

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM101	Basic Analytical Chemistry	PCC	3 -1 - 0	4

Course Learning Objectives:

1. To understand the basics of analysis and analytical chemistry.
2. To know the steps involved in quantitative analysis.
3. To learn about accuracy, precision, and the types of errors.
4. To learn about the concept of equilibrium and the types of equilibria with respect to analytical chemistry.
5. To learn about the spectrophotometric determination of complex compounds using Job's method.
6. To learn about the principles of Atomic Adsorption Spectroscopy.

Syllabus

Unit I - Introduction

(10 Hours)

Scope & objectives, Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bipartite classification), Data organisation, Analytical validations, Limit of detection and limit of quantitation, tools of analytical chemistry and good lab practices.

Unit II - Errors in Chemical Analysis and Statistical Evaluation of Data

(12 Hours)

Systematic and random errors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least square method for linear plots), statistics of sampling and detection limit evaluation.

Unit III - Concept of Equilibrium

(13 Hours)

Solvents and solutions, general treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases. Activity and concentration, Effect of electrolytes on chemical equilibria, Calculation of pH, Constructing titration curves from charge balance and mass balance equations, Acid-base titrations and theory of pH indicators,

Unit IV- Titrimetric analysis

(9 Hours)

Complexation equilibria and complexometric titrations, Redox equilibria and redox titration, Theory of redox indicators, Precipitation reaction and precipitation titrations and theory of adsorption indicators.

Unit V – Spectrophotometric Determination of Stoichiometry of Complexes (8 Hours)

Job's method of continuous variation, mole ratio and slope ratio analysis, Advantages and limitations, Typical examples.

Unit VI - Flame Photometer and Atomic Adsorption Spectroscopy (AAS) (8 Hours)

Principle of Flame photometer, Instrumentation, Applications. Atomic Adsorption Spectroscopy- Principle, Instrumentation, Applications and Limitations.

Learning Resources:

1. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, 2nd Edition (1976), John Wiley, New York.
2. G. D. Christian, *Analytical Chemistry*, 5th Edition (1994), John Wiley & Sons, New York.
3. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Analytical Chemistry - An Introduction*, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
4. J. H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London.

Web resources:

<https://nptel.ac.in/courses/104/104/104104066/>

<https://nptel.ac.in/courses/104/105/104105084/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Differentiate between qualitative and quantitative analysis
CO 2	Identify the types of errors
CO 3	Construct the titration curves from charge balance and mass balance equations
CO 4	Apply the concept of equilibria to determine pH and acid-base titrations etc.
CO 5	Know the type of complex from Job's method
CO 6	Learn about the principles Atomic Adsorption Spectroscopy

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course Code	Course Name	L	T	P	C
CYM102	Chemistry lab for Minors	0	0	3	3

Course Learning Objectives:

1. To identify the cation and anion present in a given simple salt
2. To estimate the unknown concentration by using analytical methods
3. To synthesis of organic compound and understand separation and Identification of organic functional groups reactions

Practical Syllabus

1. Qualitative analysis: Inorganic salt mixtures containing two cations and two anions (Minimum 4 salts to be analyzed)
2. Precipitation titrations: NaCl vs AgNO₃
3. Gravimetric analysis: Estimation of Nickel using Dimethylglyoxime (DMG)
4. Verification of Beer's law using KMnO₄
5. Determination of cell constant of given electrochemical cell
6. CST of phenol – water system
7. Dissociation constant of a weak acid: by electrometric method; using indicator by spectrophotometric method
8. Determination of the order of the reaction: Decomposition of H₂O₂
9. Hydrolysis of ester in alkaline medium
10. Synthesis of Benzoic acid
11. Separation and purification techniques in organic chemistry
Recrystallization; Distillation; Extraction
12. Determination of CMC by surface tension method
13. Separation and Identification of organic functional groups reactions.
(Aldehydes & Ketones; Phenols; 1^o – amines, Carboxylic acids, Halogen compounds only)

Text Books:

1. *Chemistry Practical Manual*, Lorven Publications
2. K. Mukkanti (2009) *Practical Engineering Chemistry*, B.S. Publication
3. Arthur J. Vogel, *A Textbook of Quantitative Analysis*.
4. Dr. Jyotsna Cherukuris *Laboratory Manual of engineering chemistry-II*, VGS Techno Series, 2012.

Course outcomes: At the end of the course, the student will be able to

CO 1	Identify the cation and anion present in a given simple salt
CO 2	Estimating the unknown concentration by using analytical methods
CO 3	Synthesizing the organic compound and understand separation and identifying of organic functional groups reactions

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM203	Industrial Inorganic Chemistry	PCC	3 -1 - 0	4

Course Learning Objectives:

1. To understand basic concepts of inorganic chemistry
2. To know the terminology, importance of coordinate covalent compounds
3. To gain knowledge industrially important various s, p & d block elements and its compounds.

Syllabus

Unit I: Atomic structure and Chemical Bonding

(10 Hours)

Structure of hydrogen atom-electrons- atoms-Aufbau principle, Pauli exclusion principle, and Hund's rule Periodic Table of elements; trends in periodic properties; Chemical bonding: Ionic solids- ionic structures, radius ratio, coordination number, limitations of radius ratio rule; Born-Haber cycle. Lattice energy, lattice defects, semiconductor, solvation energy. Polarization and polarizing power, Fajan's rule VSEPR theory, Valence bond theory, covalent bond, hybridization. Molecular orbital theory, MO diagram for homonuclear and heteronuclear diatomic molecules. Bent rule, bond energy, percentage of ionic character Metallic bond, free electrons, band theory, Hydrogen bond, van der Waals forces

Unit II: Coordination chemistry

(10 Hours)

Werner's coordination theory and its experimental verification Effective atomic number concept, chelates, chelates effects. Nomenclature of coordination compounds. Isomerism (geometrical and optical). Valence Bond Theory of coordination complexes and its limitations. Crystal Field Theory: d-orbital splitting in various ligand fields. **Introduction to industrial chemicals:** Importance of chemical industry, Chemicals from materials-Bulk and commodity chemicals-Fine and speciality chemicals-Water-Hydrogen. Inorganic peroxide compounds-Nitrogen compounds-Chloramine and hydroxylamine-Nitric acid, Ostwald process and uses.

Unit III: Phosphorous and its compounds

(10 Hours)

Phosphorous and its compounds -phosphoric acid salts-Tetrapotassium diphosphate preparation-Hydroxy apatite- P_4S_{10} -Sulfur compounds and Sulfur from H_2S and SO_2 - Sulfuric acid, catalyst and S_2Cl_2 , applications-Sulfur dichloride, thionyl chloride-thiosulfates and dithionite- Sodium hydroxyl methanesulfinate and hydrogen sulfide

Unit IV: Halogens and its compounds**(10 Hours)**

Halogen and halogen compounds-Fluorine and inorganic fluorides-Hydrogen fluoride and aluminium fluoride-Cryolite and other industrially important fluoride salts-Electrochemical fluorination-Sulfonyl fluorides-Chloralkali electrolysis-Ion conduction membrane in electrolysis-Hydrochloric acid manufacture-Hydrochloric acid manufacture-Bromine and its compounds-Hydrogen bromide and alkali bromates-Iodine and its compounds

Unit V: Mineral fertilizers**(10 Hours)**

Mineral fertilizers-Nitrogen fertilizer and urea-Potassium fertilizer; Metals and their compounds-Lithium-Sodium and its compounds-Potassium and its compounds-Magnesium and its compounds. Barium and its compounds-Chromium and its compounds-Manganese and its industrially important compounds. Silicon and its compounds-Organosilicon compounds, organoalkoxysilanes-Organomercapto silanes and silicones-Silicone rubber

Unit VI : Inorganic solids**(10 Hours)**

Inorganic solids-glass-Zeolites-Inorganic fibres-asbestons-textile glasss and optical fibres. Glass fibre production and construction materials. Ceramics and its manufacturing processes-ceramic products speciality-Ferrites and porcelain enamel-Layers of enamelling.

Learning Resources:**Text books:**

Hans-Heinrich M., Karl Heinz B., Peter W., *Industrial Inorganic Chemistry*, 2nd Edition 2007.

Reference Books:

Benvenuto, Mark Anthony, *Industrial Inorganic Chemistry*, 2015

Web resources:

NPTEL, Inorganic Chemistry, <https://nptel.ac.in/syllabus/104105103/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Apply the basic concepts of inorganic chemistry in identifying properties of inorganic compounds
CO 2	Analyze the importance of coordinate covalent compounds.
CO 3	Applying the industrially important various s, p & d block elements and its compounds in various sectors.

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM105	Electrochemistry, Corrosion and Fuel Chemistry	PCC	3 -0 - 0	3

Course Learning Objectives:

1. To understand the interchange of Electrical energy into chemical energy
2. To understand the relationship between chemical energy,(Gibbs free energy change for a redox reaction)
3. To understand the concept of corrosion and theories of corrosion
4. To understand the various principles of prevention of corrosion
5. To understand the classification of fuels and refinery of fuels

Syllabus

Unit I: Basic concept of electrochemistry

(8 Hours)

Concept of free energy, cell potential and emf, reversible and irreversible cell reaction, cell potential determination, Nernst equation and their application in estimating thermodynamic properties. Concept of single electrode potential, reference electrodes, half cell reaction, types of reference electrode-SHE, Ag-AgCl, SCE, Cu-CuSO₄. Electrode-Solution interface- over potential, Definition and types of polarization-factors affecting them.

Unit II: Electrochemical interfaces and Electrochemical energy systems

(8 Hours)

Origins of Electrode Potentials; Electrode/Solution Interface, electrical double layer, Lippmann equation, Helmholtz and Gouy – Chapman – Stern models of the double layer, Modern theories of electrical double layer, Adsorption of ions and dipoles. Energy storage devices – batteries and fuel cells. Electrochemical Supercapacitors.

Unit III: Basic concept of Corrosion

(7 Hours)

Technological importance of corrosion study-Introduction to corrosion, definition, learning objectives, Degradation process-Mechanical and Chemical process. Dry corrosion and wet corrosion. Local and uniform corrosion. Cost of corrosion-direct loss and indirect loss, cost of corrosion in various industries. Electrochemical principles of corrosion-cell analogy, cathode, anode, electrolyte, cathodic and anodic reactions, types of corrosion cell, e.m.f and galvanic series-their uses in corrosion studies, Passivity-Definitions and influencing parameters

Unit IV: Different forms of corrosion**(7 Hours)**

Different forms of corrosion – Mechanism, characteristic features, causes and remedial measures of uniform corrosion, galvanic corrosion, crevice corrosion, Pitting corrosion, intergranular corrosion (including weld decay & knife-line attack), Erosion corrosion, filiform corrosion, selective leaching and stress corrosion cracking,

Unit V: Principles of corrosion prevention**(7 Hours)**

Principles of corrosion prevention-material selection and design considerations control of environment including inhibitors; Cathodic protection-principle; influencing factors and design aspects, Anodic protection-principle, influencing factors and design aspects, Conversion Coatings.

Unit VI: Fuels and combustion**(8 Hours)**

Fuels and combustion– Classification, Experimental and theoretical calculation of calorific value of a fuel, Classification of coal by rank, Petroleum refining and cracking process, Gasoline, Kerosene, Combustion, calculation of air quantity.

Learning Resources:**Text books:**

1. John O'M. Bockris, Amulya K.N. Reddy, Modern Electrochemistry
- 2) Samuel Glasstone, An Introduction To Electrochemistry

Reference Books:

- 3) M. G. Fontana, Corrosion Engineering
- 4) R. W. Revie & H. H. Uhlig, Corrosion and corrosion control
- 5) Philip A. Schweitzer, Fundamentals of Corrosion
- 6) Samir Sarkar, Fuels and Combustion.

Web resources:

<https://nptel.ac.in/courses/113/104/113104082/>

<https://nptel.ac.in/courses/113/104/113104089/>

<https://nptel.ac.in/courses/103/105/103105110/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Student will understand basic concept of the electrochemistry
CO 2	Student will understand concept of corrosion and reasons for the corrosion
CO 3	Student will understand how to prevent the corrosion
CO 4	Student will understand the different types fuels and refinery process of fuels

CO 5	Student will understand how the usage fuels will lead to the air pollution
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Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM106	Nanomaterials	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To understand the classification of various nanomaterials
2. To know the various synthetic aspects for the design of nanostructured materials
3. To understand different analytical methods used for characterization of nanomaterials
4. To understand the importance of nanomaterials through their unique properties
5. To understand the applications of nanomaterials

Syllabus

Unit I: Introduction to Nanomaterials

(6 Hours)

Basic concepts – nanomaterial, nanoparticle, nanoscience, and nanotechnology; History and evolution of nanotechnology; Importance of size reduction of a material, Classification of nanomaterials – 0D, 1D, 2D, and 3D nanostructures.

Unit II: Bottom-up and Top-down Synthesis of Nanomaterials

(8 Hours)

Nucleation and growth processes. Bottom-up methods of synthesis: sol-gel, precipitation, chemical reduction; solvothermal, micro-emulsion, hydrothermal, chemical vapor deposition, γ -ray irradiation; Top-down methods of synthesis: ball milling, thermal evaporation, laser ablation, electron beam evaporation, and sputtering.

Unit III: Characterization of Nanomaterials

(8 Hours)

Characterization by powder X-ray diffraction (XRD), Crystallite size calculations using Scherrer's equation; Principles and instrumentation – Electron microscopic techniques, scanning electron microscope (SEM), transmission electron microscope (TEM); Energy Dispersive Spectroscopy (EDS), Selected Area Electron Diffraction (SAED); Atomic Force Microscope (AFM)

Unit IV: Size Dependent Properties of Nanomaterials

(8 Hours)

Melting point, lattice parameters; Optical properties of nanomaterials – surface plasmon resonance bands; Quantum dots; Magnetic properties of nanomaterials – superparamagnetism; Mechanical properties of nanomaterials; Electrical properties of nanomaterials.

Unit V: An Overview on Different Nanomaterials**(8 Hours)**

Nanocomposites – Introduction, Classification of nanocomposites – polymer nanocomposites, core-shell nanomaterials – applications; Carbon nanotubes (CNTs) – Introduction, synthesis, properties and applications; Graphene – Introduction, synthesis, properties and applications. Organic nanomaterials – Introduction, classification, and preparation.

Unit-VI Applications of Nanomaterials**(7 Hours)**

Data storage applications; Biomedical applications – Targeted drug delivery – nanorobots (Nanobots); Hyperthermia, MRI contrast agents; Energy storage applications; Environmental remediation – Degradation of dyes, phenol compounds in water; Applications in catalysis.

Learning Resources:**Text books:**

1. The Chemistry of Nanomaterials: Synthesis, Properties and Applications. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds.), (2004) WILEY-VCH Verlag GmbH & Co., Weinheim
2. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J. Owens, Wiley Student Edition, 2008

Reference Books:

1. T. Pradeep, “Nano: The Essentials Understanding Nanoscience and Nanotechnology”, Tata McGraw-Hill Publishing Company Limited, 2001.
2. Kenneth J. Klabunde, “Nanoscale Materials in Chemistry”, John Wiley & Sons Inc., 2001.
3. Jose A. Rodriguez, Marcos Fernandez-Gracia, “Synthesis, Properties, and Applications of Oxide Nanomaterials”, John Wiley & Sons Inc., 2007.
4. K. T. Ramesh, “Nanomaterials: Mechanics & Mechanisms”, Springer Science, 2009.
5. G. Schmid, “Nanoparticles: From Theory to Application, second edition, Wiley VCH, 2010
6. Polymer – clay Nanocomposite – T.J. Pinnayain, G.W. Beall, Wiley, New York 2001.

Web resources:

<https://nptel.ac.in/courses/118/104/118104008/>
<https://nptel.ac.in/courses/118/102/118102003/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Applying different synthetic methods for the preparation of Nanomaterials
CO 2	Analyzing the nanomaterials using various characterization methods
CO 3	Understanding the importance of nanomaterials due to their unique properties

CO 4	Understanding the existence of various nanomaterials and their importance in various diversified fields of technology
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Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM107	Catalysis	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To know about fundamental aspects of catalyst and its role in chemical reactions.
2. To understand about different hetero and homo catalytic process
3. To acquire knowledge about influence of catalyst in organic reactions
4. To characterize activity of catalyst

Syllabus

Unit-I: Introduction to catalysis

(8 Hours)

Catalytic reactions-Heterogeneous catalyst-Homogeneous catalyst-Relative significance-Heterogeneous catalytic theory-Adsorption on solid surfaces: Importance of adsorption in solid catalysis-Types of adsorption, Comparison-Enzyme Catalysis-Solid catalysis, types of catalysts, catalyst formulations and Preparation methods. Catalysts promoters, Inhibitors, catalyst deactivations.

Unit-II: Catalytic activity and selectivity studies

(8 Hours)

Testing of catalysts, various types of reactors, activity and selectivity studies; Effect of external transport processes on observed rate of reactions. Effect of internal transport processes: reactions and diffusion in porous catalysts. Mechanism of catalytic reactions, Rates of adsorption, desorption, surface reactions, rate determining steps.

Unit-III: Catalytic processes in industry

(7 Hours)

The role of catalytic processes in modern chemical manufacturing: the reaction rate and the selectivity of chemical reactions-**Heterogenous catalyst** in commercially important reactions: Contact process-Haber process-Ostwald process-Water-Gas shift reactions –Steam reforming-Methanol synthesis- Sohio process; **Homogenous catalysts** in commercially important reactions- H₂O₂ process-Hydroformylation-adiponitrile process-Olefin polymerization.

Unit-IV: Catalytic processes in organic chemistry

(7 Hours)

Catalyst in organic chemistry: acid catalysis Nitration of benzene-Hydration of ethane to ethanol-Hydrolysis of esters; Other catalyst: Halogenation of benzene-reaction with chlorine-reaction with bromine-The Friedel-Crafts alkylation of benzene-Friedel-crafts acylation of benzene-Catalysis in environmental control. Catalysis in petrochemical industry: cracking- Isomerisation-Reforming

Unit-V: Characterization of catalysts**(8 Hours)**

Catalysts Characterization methods : Surface area and pore volume determinations, XRD, various Spectroscopic techniques, Temperature programmed reduction & oxidation, Electron microscopy Testing of catalysts, various types of reactors, activity and selectivity studies-

Unit-VI: Developments in Solid catalysts**(7 Hours)**

New development in solid catalysis, monolith catalysts , nanocatalysts, Fuel cell catalysts.

Learning Resources:**Text books:**

1. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press.
2. J. M. Smith , "Chemical Engineering Kinetics" McGraw-Hill Book Company.
3. J. M. Thomas and W. J. Thomas, "Principles and Practice of Heterogeneous Catalysis", Wiley- VCH.
4. H. S. Fogler, "Elements of Chemical reaction engineering" Prentice - Hall of India.
5. J.J. Carberry , "Chemical and catalytic reaction Engineering", Dover Publications.
6. C. H. Bartholomew and R. J. Farrauto "Fundamentals of Industrial catalytic Processes", Wiley- VCH.

Web resources:

<https://nptel.ac.in/syllabus/syllabus.php?subjectId=103103026>

<https://nptel.ac.in/syllabus/syllabus.php?subjectId=103102012>

Course outcomes: At the end of the course, the student will be able to

CO 1	Apply the basic reasons for reactivity of catalyst
CO 2	Identify the importance of catalyst in organic reactions, inorganic industrial chemical preparation
CO 3	To recognize efficiency of catalyst in reaction

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM108	Food Chemistry	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To get knowledge about interaction of water with food particles
2. To acquire basic knowledge on types of carbohydrates
3. To understand lipid components and its properties
4. To understand about Proteins, Peptides and Proteins.
5. To know about exogenous and endogenous enzymes in food

Syllabus

Unit-I: Water relations in Food Chemistry

(8 Hours)

Introduction: History, Approaches - Water & Ice: Physical properties of water and ice-Water solute interaction-Water activity.

Unit-II: Carbohydrates

(7 Hours)

Structure and functional properties of mono- oligo- & polysaccharides including starch, Cellulose, pectin substances and dietary fibre, gelatinization and retro gradation of starch

Unit-III: Lipids

(7 Hours)

Introduction-Major Lipid components-Physicochemical properties of Lipids-Lipid processing: Isolation, Purification & modification-Functionality of Triacylglycerols in food

Unit-IV: Amino acids, Peptides & Proteins

(7 Hours)

Introduction-Physicochemical properties of Amino acids-Protein Denaturation-Functional properties of proteins- Nutritional properties of proteins

Unit-V: Enzymes

(7 Hours)

Introduction-General nature of Enzymes- Uses of Exogenous enzymes in foods-Environmental Influence on enzyme action- Enzymes endogenous to food and their control

Unit-VI: Vitamins/Minerals

(9 Hours)

Introduction-Addition of nutrients to foods- Bioavailability of Vitamins-General causes of variation/Loses of vitamins in food. Minerals: Introduction-Principles of mineral chemistry-Nutritional aspects of Minerals-Mineral composition of food. Food Processing: Chemistry of Milk

Learning Resources:**Text books:**

1. Swaminathan M., *Text Book on Food chemistry*, Printing and Publishing CO., Ltd., Bangalore. 1993.
2. John M. deMan, John M. deMan (3rd Edition) (3rd Edition)

Reference Books:

1. Owen R Fennema, *Food Chemistry*, Marcel Decker Inc., New York. 1996.
2. Srilakshmi B., *Food Science*, New age International Pvt. Ltd. Publishers, III ed. 2003.
3. Norman N. Potter, *Food science*, CBS publishers and distributors, New Delhi. 1994
4. Zdzisław E. Sikorski, *Chemical and Functional Properties of Food Components* (3rd Edition).

Course outcomes: At the end of the course, the student will be able to

CO 1	Explain water influence with food
CO 2	To classify types of carbohydrates and its properties
CO 3	To understand lipid components and its properties
CO 4	To nutritional properties of proteins
CO 5	Analyze influence of exogenous and endogenous enzymes on food substances.

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM109	Introduction to Quantum Chemistry	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To develop the student understanding of atomic and molecular structure and properties, as well as chemical reactivity.
2. To provide an introduction to the mathematical foundations of quantum chemistry, as well as a practical, hands-on experience with a quantum mechanics software package
3. To understand dual nature of the particle, eigen functions and eigen values of the Hamiltonian operator
4. To write and solve the Schrödinger Eq. for model systems

Syllabus

UNIT- I: Fundamentals of Quantum Chemistry

(8 Hours)

Wave particle duality, uncertainty principle, standing waves, stationary states, atomic orbitals, path integrals and random walks, Postulates of Quantum Mechanics

UNIT- II: Simple Systems

(8 Hours)

Particle in a box, particle in a box of finite depth, The free particle, and the derivation of the uncertainty principle, Particle encountering a barrier, tunneling, Tunneling in chemistry

UNIT- III: Model Systems-I

(7 Hours)

Particle in a ring, The Harmonic Oscillator

UNIT –IV: Model Systems-II

(7 Hours)

Particle on a sphere, The Hydrogen Atom

UNIT- V: Approximation Methods

(7 Hours)

The variation and perturbation method, Time dependent problems

UNIT- VI: Applications

(8 Hours)

Hydrogen Molecule ion, Born Oppenheimer approximation, LCAO, MO method for H₂, Benzene, and ethylene molecules

Learning Resources:**Text books:**

1. Pauling and Wilson, Introduction to Quantum Mechanics, Dover Edition

Reference Books:

1. Schwabl, Quantum Mechanics, Springer Books
2. P.M. Mathews and Venkatesan, Quantum Mechanics, Tata McGraw Hill

Web resources:

<https://nptel.ac.in/courses/104/106/104106083/>

<https://nptel.ac.in/courses/104/108/104108057/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Foundations of quantum mechanics to remind the difference between classical and quantum world
CO 2	See how operator algebra can be used to solve simple eigen value problems
CO 3	Understand what is meant by the orbital concept
CO 4	The role of rotational and spin angular momenta in chemistry and Be able to develop the Hamiltonian operator for different model systems

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM210	Electro analytical & electrochemical methods of analysis	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To comprehend the factors that must be controlled to obtain reliable and reproducible data from electro analytical experiments.
2. To identify the most appropriate electro analytical technique for a specific analysis.
3. To gain skills in the consolidation of information from results obtained from two or more electroanalytical techniques.

Syllabus

Unit I: Introduction to electroanalytical methods

(7 Hours)

Theoretical principles of electroanalytical chemistry, electrodes, polarization and depolarization, electrochemical cells.

Unit II: Potentiometric methods

(7 Hours)

Electrode reactions, kinetics, reversibility and irreversibility. Potentiometry, potentiometric electrodes, pH measurement, membrane and ion-selective electrodes, potentiometric titrations

Unit III: Voltametric methods

(8 Hours)

Voltametric methods, polarography, linear sweep voltammetry, cyclic and hydrodynamic voltammetry, voltammetric titrations. Pulse voltammetric methods, modified electrodes, microelectrodes, stripping voltammetry.

Unit IV: Polarography

(8 Hours)

Principles of electrochemical methods, electrochemical reactions, steady-state and potential step techniques; polarography, cyclic voltammetry

Unit V: Other Electrochemical techniques-1

(8 Hours)

Potential controlled coulometry, coulometric titrations, conductometry and high-frequency conductometry. Electrochemical flow analysis and microanalysis, application of electroanalytical methods in process analysis.

Unit VI: Other Electrochemical techniques-2**(7 Hours)**

Potentiometry, descriptions of the double layer, chronoamperometry, chronocoulometry, chronopotentiometry, impedance spectroscopy, chemically modified electrodes, spectroelectrochemistry, electrochemical imaging methods.

Learning Resources:**Reference Books:**

1. Electrochemical Methods: Fundamentals and Applications, 2nd ed., Bard, A.J. and Faulkner, L.R., 2001, John Wiley & Sons.
2. Analytical Electrochemistry, Wang, J., 2006, John Wiley & Sons.
3. Fundamentals of Electroanalytical Chemistry, Monk, P., 2001, John Wiley & Sons.

Web resources:

<http://web.natur.cuni.cz/~opekar/elchemchzp/C230P46.html>

<https://nptel.ac.in/courses/103/108/103108162/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Gain knowledge of the theoretical foundations of electroanalytical chemistry.
CO 2	Learn about the electrodes, polarization and depolarization, electrochemical cells, electrode reactions, kinetics, reversibility and irreversibility.
CO 3	Understand potentiometry, potentiometric electrodes, pH measurement, membrane and ion-selective electrodes.
CO 4	Gain knowledge on pulse voltammetric methods, modified electrodes and microelectrodes, stripping voltametry, potential controlled coulometry, coulometric titrations, conductometry and high-frequency conductometry, electrochemical flow analysis and application of electroanalytical methods in process analysis.

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM211	Advanced Functional Materials for Electronic and Energy Applications	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To identify the functional materials using a methodology
2. To distinguish various chemical routes for the preparation of functional materials.
3. To interpret various materials with structure – property relationships.
4. To characterize the functional materials using various diffraction and microscopic techniques.

Syllabus

Unit I: Introduction to Materials

(8 Hours)

Periodic table – physical and chemical properties of elements, Polymers – covalent bonds, natural & synthetic fibers, paper, polymerization reactions, Ceramics – pottery, heat and reactions, glass, concrete, Dyes – light & color, interactions with fibres, Semi conductors– electronic structure of solids, transistors, light emitting diodes.

Unit II: Advanced Materials and Materials under Technological Importance (7 Hours)

Nanomaterials – 3D, 2D, 1D, OD nanosystems, Self assemblies of nanoparticles, Nanosystems – catalysis, Quantum dots, Smart materials, Organic semiconductors – Optoelectronic materials, Surface coating technology, High temperature superconducting materials.

Unit III: Materials for Energy Applications

(7 Hours)

Materials for hydro power applications, Slit characteristics, Materials for thermal power generation, Creep and creep resistant materials, Materials for energy storage – Rechargeable batteries, Lead-acid, Li-ion, Ni-Cd, Ni-MH batteries.

Unit IV: Chemical and Non-chemical Approaches to Materials Synthesis (8 Hours)

Solution based material synthesis – Precipitation methods, hydrothermal etc., Solution based materials synthesis - Micro – emulsion, Sol – gel, Phase transfer reactions, Synthesis and properties of monolayer capped metal nanoparticles, Material synthesis using microwave radiation and ultra sonic waves, Solid state synthesis, Hybrid methods for materials synthesis – synthesis of rational shaped molecules and semiconductors.

Unit V: Fabrication Techniques based on Solution and Depositions (8 Hours)

Fabrication techniques - Pulsed laser Deposition (PLD), Fabrication techniques – Pulsed Electron Deposition (PED), Molecular Beam Epitaxy (MBE), Magnetron Sputtering, Chemical Vapor deposition (CVD), Metal – organic chemical vapor deposition (MOCVD).

Unit VI: Characterization of Materials (7 Hours)

UV –visible spectrophotometer, Fluorimeter, Particle size analyzer, Powder X – ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X – ray photoelectron spectroscopy (XPS), Atomic force microscopy (AFM) – Scanning probe microscopy (SPM), Electron beam lithography.

Learning Resources:**Text books:**

1. The Chemistry of Nanomaterials: Synthesis, Properties and Applications. C. N. R. Rao

Reference Books:

1. Anthony R. West, “Solid State Chemistry and its Applications”, 2nd edition, Wiley, 2013.
2. Bradley D. Fahlman, “Materials Chemistry”, 2nd edition, Springer, 2011.
3. L. Murr, “Industrial Materials Science and Engineering” Marcel Dekker Inc., 1984.
4. T. Pradeep, “Nano: The Essentials Understanding Nanoscience and Nanotechnology”, Tata McGraw-Hill Publishing Company Limited, 2001.
5. Kenneth J. Klabunde, “Nanoscale Materials in Chemistry”, John Wiley & Sons Inc., 2001.

Web resources:

<https://nptel.ac.in/courses/104/104/104104011/>

<https://nptel.ac.in/courses/104/103/104103019/>

NPTEL, Chemistry, <https://nptel.ac.in/course.php>

Course outcomes: At the end of the course, the student will be able to

CO 1	Identify the functional materials using a methodology
CO 2	Understand various chemical routes for the preparation of materials
CO 3	Learn various types of polymeric, magnetic materials
CO 4	Able to characterize the functional materials

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CY4212	Environmental and Green Chemistry	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To understand the basic principles of green and sustainable chemistry
2. To understand Air pollution and its preventions methods
3. To understand water pollution and its preventions methods
4. To understand the biological treatment and solid waste disposal
5. To understand few named reaction taking place in aqueous media

Syllabus

UNIT-I: Introduction

(6 Hours)

Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents

UNIT-II: Air Pollution Control

(8 Hours)

Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers

UNIT-III: Water Pollution Control

(8 Hours)

Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation

UNIT-IV: Biological Treatment and Solids Disposal

(8 Hours)

Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying, Solids waste disposal – composting, landfill, briquetting / gasification and incineration.

UNIT-V: Concepts of Green Chemistry

(7 Hours)

Introduction to Green Chemistry, Principles of Green Chemistry, Solvent less reactions, Microwave assisted synthesis, Phase Transfer catalysis, Ultra sonication, ionic liquid based synthesis.

UNIT VI- Aqueous Phase Reactions:

(8 Hours)

Diels-Alder reaction, Claisen rearrangement, Wittig-Horner reaction, Michael reaction, Aldol condensation, Knoevenagel reaction, Pinacol coupling, Benzoin condensation Claisen Schmidt condensation. Strecker synthesis, Wurtz reaction, Oxidations, Reductions, Polymerization reactions, Photochemical reactions, Electrochemical synthesis.

Learning Resources:

Text books:

1. Pollution Control Acts, Rules, Notifications issued there under" CPCB, Ministry of Env. and Forest, G.O.I., 3rd Ed. 2006.

Reference Books:

References:

1. "Pollution Control Acts, Rules, Notifications issued there under" CPCB, Ministry of Env. and Forest, G.O.I., 3rd Ed. 2006.
2. Vallero D; "Fundamentals of Air Pollution", 4 th Ed; Academic Press.
3. Eckenfelder W.W; "Industrial Water Pollution Control", 2 Ed; McGraw Hill.
4. Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2 Ed; McGraw Hill.
5. Pichtel J; "Waste Management Practices: Municipal, Hazardous and Industrial", CRC.
6. Tchobanoglous G., Burton F. L. and Stensel H.D., "Waste Water Engineering: Treatment and Reuse", 4th Ed; Tata McGraw Hill.
7. New Trends in Green Chemistry by V.K. Ahluwalia, M.Kidwai(AnamayaPublishro New Delhi)
8. Introduction to Green Chemistry by V.Kumar

Web resources:

<https://nptel.ac.in/courses/105/107/105107176/>

<https://nptel.ac.in/courses/127/105/127105018/>

Course outcomes: At the end of the course, the student will be able to

CO 1	Identigy types of pollution and its prevention
CO 2	Analyze the air pollution causes and its prevention measures
CO 3	Evaluate the reasons for water pollution and its prevention measures

CO 4	Distinguish methods of the biological treatment of waste water and solid waste disposal
CO 5	Identify various aqueous phase reactions

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM213	Computational Methods in Chemistry	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To prepare students for data analysis, hypothesis generation and validation and to acquaint students with latest trends in computer aided molecule/material design.
2. To study the relationships between molecular structure and chemical functionality/property.

Syllabus

Unit I: Introduction

(8 Hours)

Chemistry & Information technology, chemical / biochemical data collection, retrieval, analysis & interpretation, hypothesis generation & validation, development of structure activity/property relationships.

Unit II: Geometry optimization and simulation methods

(8 Hours)

Building molecules on a computer, quantum chemical calculations and molecular mechanical calculations and methods for geometry optimization, Simulation methods for molecules and materials.

Unit III: DFT calculations

(8 Hours)

Gaussian Software: Molecular Optimization-HOMO-LUMO; DFT calculations.

Unit IV: Molecular Dynamics

(7 Hours)

Classical Molecular Dynamics (MD): (Newtonian dynamics, Integration algorithm, Periodic boundary conditions and minimum image convention, Potential truncation and shifted-force potentials, Neighbor list, Force calculations, Long range interactions, MD code for liquid Argon.).

Unit V: Random numbers

(7 Hours)

Classical Monte Carlo (MC): (Random numbers, evaluating integrals using random numbers.

Unit VI: Applications

(7 Hours)

Analysis of simulated trajectories: (Radial distribution functions, Self diffusion coefficient, Time correlation functions), Applications of modeling in Materials chemistry.

Learning Resources:

Reference Books:

1. Gasteiger, J., Engel, T., Chemoinformatics, Wiley-VCH, 2008.
2. Cramer, C.J., Essentials of Computational Chemistry, 2nd Ed., John Wiley & Sons Ltd., 2004.
3. Leach, A. R., Molecular Modelling: Principles and Applications, Longman, 1996.
4. D. Frenkel and B. Smit, Understanding Molecular Simulations: From Algorithms to Applications, Second Edition, Academic Press, 2002.
5. M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Oxford University Press, 1987.

Course outcomes: At the end of the course, the student will be able to

CO 1	Interpret and practice the fundamental concepts of Molecular Modeling.
CO 2	Identify some of the complex methods like Quantum Mechanics.
CO 3	Build the molecules using the appropriate tools and Apply the perfect optimization method for the molecules.
CO 4	Learn the simulation softwares and practice the softwares for various molecules.

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CY4214	Electrochemical Energy Systems	PEC	3 -0 - 0	3

Course Learning Objectives:

1. To gain knowledge of the basic operating principles several energy technologies
2. To understand important relationships between relevant basic energy carriers and the performance of energy technologies
3. To gain experience applying basic design principles to integrate nanostructures into energy technologies for performance improvement

Syllabus

UNIT-I: Fundamental Concepts in Energy Systems (7 Hours)

Electrochemical Cell, Faraday's laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photoelectrochemical cell, thermoelectric effect

UNIT-II: Nanomaterials for Energy Conversion Systems (8 Hours)

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy, Conversion Systems, Fuel Cells, Principles and nanomaterials design for proton exchange membrane fuel cells (PEMFC); Direct methanol fuel cells (DMFC); Solid-oxide fuel cells (SOFC)

UNIT-III: Nanomaterials for Photovoltaic Solar Energy Conversion Systems (8 Hours)

Principles of photovoltaic energy conversion (PV), Types of photovoltaic Cells, Organic photovoltaic cell cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells

UNIT- IV: Nanocrystalline solar cells: (8 Hours)

Dye-sensitized solar cells – cell operation, materials – semiconductor-sensitized solar cells (SSSC) – liquid junction SSSCs – recombination rates in semiconductors – back-transport of electrons from oxide to absorbing semiconductor – electron injection from oxide / substrate into electrolyte

UNIT-V: Nanomaterials for Energy Storage (Batteries) Systems-1 (7 Hours)

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium ion Batteries)

UNIT-VI: Nanomaterials for Energy Storage (Batteries) Systems-2 (7 Hours)

Cathode and anode materials, Nanostructured Carbon based materials, Nano-Oxides, Novel hybrid electrode materials.

Learning Resources:

Text books:

1. Linden , “Hand book of Batteries and fuel cells”, Mc Graw Hill, 1984.
2. Hoogers , “Fuel cell technology handbook”. CRC Press, 2003.
3. Vielstich, “Handbook of fuel cells: Fuel cell technology and applications”, Wiley, CRC Press, 2003

Reference Books:

1. G. Chen, Nanoscale Energy Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons, Oxford Press, 2005.
2. Z. M. Zhang, Nano/Microscale Heat Transfer, McGraw-Hill, New York, 2007
3. D. L. Schodek, P. Ferreira, M. F. Ashby, Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects, Butterworth-Heinemann, 2009

Web resources: <https://nptel.ac.in/course.php>

Course outcomes: At the end of the course, the student will be able to

CO 1	To derive the fundamental laws related to energy systems.
CO 2	To analyze nanostructure materials involving electrochemical energy.
CO 3	To classify various types of photovoltaic cell as energy conversion
CO 4	To illustrate semiconductor-sensitized solar cells (SSSC)
CO 5	To identify challenges nanostructured materials as energy storages systems

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies

Department of Chemistry

Course code	Course name	Course Category	L-T-P	Credits
CYM215	Molecular Spectroscopy	PEC	3 -0 - 0	3

Course Learning Objectives:

1. Student will learn spectroscopic methods for qualitative and quantitative analysis.
2. Student will learn the how the rotational energy of molecule will interact with microwave radiation energy
3. Student will learn about vibrational spectroscopy and functional group analysis of organic compounds
4. Student will learn about electronic transitions and its shifts and applications

Syllabus

Unit-I: Introduction

(7Hours)

Introduction, characterization of electromagnetic spectrum, Quantization of energy, spectrum and spectra, signal-to-noise ratio, the width and intensity of spectral transitions, fourier transform spectroscopy.

Unit-II: Microwave spectroscopy

(7 Hours)

Classification of molecules, rigid rotor model, effect of isotope substitution on the transition frequencies, intensities, no-rigid rotor, stark effect.

Unit-III: Infrared spectroscopy

(8 Hours)

Linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant, bond strengths, anharmonicity, Morse potential diagram, vibrational-rotational spectroscopy, PQR branches, vibrations of simple polyatomic molecules, selection rules, exclusion principle.

Unit-IV: Raman spectroscopy

(8 Hours)

Raman effect, classical and quantum theories of quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules.

Unit-V: Electronic spectroscopy of atoms

(8 Hours)

The structure of atoms, electronic angular momentum, many electron atoms, photoelectron spectroscopy, The Zeeman effect, the influence of nuclear spin

Unit-VI: Surface spectroscopy**(7 Hours)**

Photoemission spectroscopy and Auger spectroscopy

Learning Resources:**Text books:**

1. Fundamentals of Molecular & Spectroscopy, Colin N. Banwell, Elaine M. McCash

Reference Books:

1. Atomic and Molecular Spectroscopy, Rita Kakkar, Cambridge university press.
2. Fundamentals of Molecular Spectroscopy, Walter S. Struve
3. Physical methods of Chemistry, R.S. Drago (Saunders college)
4. Modern spectroscopy, M. Hollas (John Wiley)
5. Introduction to molecular spectroscopy, G.M. Barrow (McGraw Hill)
6. Molecular Spectroscopy, Arul Das
7. Molecular Spectroscopy, Hertz Berg, Strager

Web resources:<https://nptel.ac.in/courses/104/106/104106083/><https://nptel.ac.in/courses/104/101/104101099/>**Course outcomes:** At the end of the course, the student will be able to

CO 1	Student will understand the interaction of emr with matter
CO 2	Understand the calculations of the inter nuclear distance
CO 3	Understands the analyzing functional groups of organic molecules
CO 4	Understands the Beer's Law and shifts of electronic transitions and the nature of solid surfaces by photoemission spectroscopy

Course Nature		Theory		
Assessment Method				
Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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