DEPARTMENT OF CHEMISTRY

SYLLABUS FOR FOUR YEAR UNDERGRADUATE PROGRAMME

FIRST AND SECOND SEMESTER

(APPROVED BY ACADEMIC COUNCIL VIDE RESOLUTION NO. 3, DATED: **04 – 07 – 23**)

ARYA VIDYAPEETH COLLEGE (AUTONOMOUS)

ARYA NAGAR, GUWAHATI – 16

INDEX

Structure of Four Year Undergraduate Course

Semester	Type	Core	Minor	SEC	IDC	AEC	VAC/FC	IN
	Credit	4	4	3	3	2	4(2 + 2)	2
I		CE-1114	MN-1114	SE-1113	ID-1113	AE-1112	VL-1112 (Two Courses)	-
II		CE-2114	MN-2114	SE-2113	ID-2113	AE-2112	VL-2112 (Two Courses)	-
III		CE-3214	MN-3214	SE-3213	ID-3213	AE-3212	-	-
		CE-3224						
IV		CE-4214	MN-4214	-	-	AE-4212	-	IN-4212
		CE-4224						
		CE-4234						
V		CE-5314	MN-5214	-	-	-	-	-
		CE-5324						
		CE-5334						
		CE-5344						
VI		CE-6314	MN-6214	-	-	-	-	-
		CE-6324						
		CE-6334						
		CE-6344						
VII		CE-7414	MN-7314	-	-	-	-	-
		CE-7424						
		CE-7434						
		CE-7444						
VIII		CE-8414	MN-8314	-	-	-	-	-
		CE-8424**						
		CE-8434**						
		CE-8444**						

****Students who secure more than 7.5 CGPA at the end of third year (6th semester) may opt for a research dissertation of 12 credits instead of the three core papers.**

Course code: **First two letters is the abbreviation of course component**

First digit implies semester number

Second digit implies course level

Third digit implies course number

Fourth digit implies credit points per course.

Digit	Course Level
1	100 - 199
2	200 - 299
3	300 - 399
4	400 - 499

Semester Wise Credit Distribution

Semester	CREDIT DISTRIBUTION							
	CORE	MINOR	SEC	AEC	IDC	VAC/FC	IN	TOTAL
FIRST	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
SECOND	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
THIRD	2 x 4	1 x 4	1 x 3	1 x 2	1 x 3	--	--	20
FOURTH	3 x 4	1 x 4	--	1 x 2	--	--	1 x 2	20
FIFTH	4 x 4	1 x 4	--	--	--	--	--	20
SIXTH	4 x 4	1 x 4	--	--	--	--	--	20
SEVENTH	4 x 4	1 x 4	--	--	--	--	--	20
EIGHT	4 x 4	1 x 4	--	--	--	--	--	20

SEC: SKILL ENHANCEMENT COURSE

AEC: ABILITY ENHANCEMENT COURSE

IDC: INTERDISCIPLINARY COURSE

VAC/FC: VALUE ADDED COURSE

IN: INTERNSHIP

Abbreviation of Course Components:

CE (Core), MN (Minor), SE(Skill Enhancement Course), AE (Ability Enhancement Course), VL (Value added Course), ID (Interdisciplinary Course), IN (Internship)

LIST OF PAPERS:

CORE:

1. **General Chemistry-I (CH – CE – 1114)**
2. **General Chemistry-II (CH – CE – 2114)**

MINOR:

1. **General Chemistry-I (CH – MN – 1114)**
2. **General Chemistry-II (CH – MN – 2114)**

SKILL ENHANCEMENT COURSE:

1. **Basic Analytical Chemistry-I (CH – SE – 1113)**
2. **Basic Analytical Chemistry-II (CH – SE – 2113)**

MULTIDISCIPLINARY/INTERDISCIPLINARY COURSE:

1. **Chemistry in Practical Life-I (CH – ID – 1113)**
2. **Chemistry in Practical Life-II(CH – ID – 2113)**

FIRST SEMESTER

PAPER NAME: General Chemistry-I
PAPER CODE: CH-CE-1114
Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 CREDITS

Total Lectures: 45

COURSE OBJECTIVE:

This course aims at giving students understanding about the basic constituents of matter – atoms, ions and molecules in terms of their electronic structure and reactivity. Structure and bonding are to be dealt with basic quantum chemistry treatment. Further, periodic classification of elements in the periodic table and changes in properties along the periods and groups to be studied in detail. The students are introduced to the principles of redox titrations in context of volumetric analysis of common metal ions. The course also apprises students with introduction to organic compounds, electron displacement, type of reagents and reaction intermediates. The chemistry of aliphatic and aromatic hydrocarbon are also included. Further, the course strives to educate the students on fundamental topics states of matter- gaseous and liquid along with ionic equilibria.

COURSE OUTCOME:

On successful completion, students would have clear understanding of the concepts related to atomic and molecular structure, chemical bonding, periodic properties and redox behaviour of chemical species. Students are expected to identify different classes of organic compounds, describe their reactivity and explain/analyze their chemical aspects. The students would learn the kinetic theory of gases, Ideal gas and real gases. In liquid state unit, the students are expected to learn the qualitative treatment of the structure of liquid along with the physical properties of liquid, viz, vapour pressure, surface tension and viscosity. The students will also learn another important topic ionic equilibria in this course.

Unit 1: Inorganic Chemistry

Atomic Structure-I:(5 Lectures)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $|\psi|^2$. Quantum numbers and their significance.

Periodicity of Elements:(7 Lectures)

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
b. Atomic radii (van der Waals), Ionic and crystal radii, Covalent radii.
c. Ionization enthalpy, factors affecting ionization energy.
d. Electron gain enthalpy, trends of electron gain enthalpy.

e. Electro negativity, Pauling's/ Mulliken's/ Alfred Rochow's electro negativity scales. Variation of electro negativity with bond order, partial charge, hybridization, group electro negativity.
f. Inert pair effect, diagonal relationship.

Oxidation-Reduction:(3 Lectures)

Principles involved in volumetric analysis of metal ion Fe^{2+} with the help of standard $KMnO_4$ and$K_2Cr_2O_7$ solution.

Unit 2: Organic Chemistry

Organic Compounds:(2 Lectures)

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements:(3 Lectures)

Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Hydrogen bonding and its effect on the properties of organic molecules; Organic acids and bases – their relative strength.

Cleavage of Bonds*:*(3 Lectures)

Homolysis and Heterolysis. Curly arrow rules, Drawing electron movement with arrows and half-headed arrows. Structure and shape of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Aliphatic Hydrocarbons: (7 Lectures)

a) Alkanes: Preparation- Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions- Free radical Substitution: Halogenation.
b) Alkenes: Preparation- Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis*-alkenes (Partial catalytic hydrogenation) and *trans*-alkenes (Birch reduction). Reactions-*cis*-addition (alkaline $KMnO_4$) and *trans*-addition (Br_2), Addition of hydrogen halides (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis.
c) Alkynes: Preparatio*n*- Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra-halides and dehydrohalogenation of vicinal-dihalides. Reactions-formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Unit 3: Physical Chemistry

Kinetic Theory of Gases:(6 Lectures)

Postulates of Kinetic theory of gases and derivation of the kinetic gas equation. Behaviour of real gases: Deviation from ideal behaviour, compressibilty factor, causes of deviation from ideal behavior, Vander Waals equaiton of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from Vander Waals equation. Andrew isotherms of CO_2.

Ionic Equilibrium:(5 Lectures)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Buffer solutions. Solubility and solubility product of sparingly soluble salts-applications of solubility product principle.

Liquids: (4 Lectures)

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

PRACTICAL:

Total Lectures: 30 (CREDIT: 1)

COURSE OBJECTIVE:

This course aims to give the students practical training and sessions to the students on preparation of standard solutions in different concentration and volumetric estimations by redox reaction. The students will be apprised with simple purification technique of recrystallization of organic compounds in various media and determine their purity. The students will also get training on pH measurements of different solutions and preparation of buffer solutions. The students will also learn to measure surface tension and viscosity of simple liquids.

COURSE OUTCOME:

Students will have hands on experience of standard solution preparation in different concentration units and learn volumetric estimation through acid-base and redox reactions. The students will learn to purify organic compounds by recrystallization. The students will be able to prepare buffer solutions and measure pH of solution, as well as determine surface tension and viscosity of simple liquids.

Oxidation-Reduction Titrimetry:

1. Preparation of solutions of different Molarity/Normality of titrants.
2. Estimation of $Fe^{2+}$and Fe^{3+} ions with the help of $K_2Cr_2O_7$and standardized $KMnO_4$ solutions.

Purification methods:

1. Purification of organic compounds by crystallization using the following solvents:
   a) Water
   b) Alcohol
   c) Alcohol-Water
2. Determination of the melting points of recrystallized compounds and unknown organic Compounds.

pH measurements:

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps using pH meter.
2. Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid.
   (ii) Ammonium chloride-ammonium hydroxide.

Surface tension measurement: (in aqueous solutions only).

1. Determination of the surface tension of a dilute solution using astalagmometer.
2. Study of the variation of surface tension of a detergent solution with concentration.

Viscosity measurement: (in aqueous solutions only).

1. Determination of the relative and absolute viscosity of dilute solution using an Ostwald's viscometer.
2. Study of the variation of viscosity of an aqueous solution with concentration of solute.

RECOMMENDED BOOKS:

THEORY:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Oxford University Press
2. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley
3. Atkins, P., Overton, T., Rourke, J., Weller, M. and Armstrong, F., Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
4. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, 9 th Ed., Oxford University Press.
5. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.
6. Negi, A.S., Anand, S.C. A Textbook of Physical Chemistry, 3 rd Ed. New Age International Publishers
7. Silbey, R. J., Alberty, R. A., Bawendi, M. G. Physical Chemistry, 4 th Ed., John Wiley & amp; Sons.
8. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2 nd Ed., Oxford University Press.
9. Bruice, P. Y. Organic Chemistry, 7 th Ed., Pearson Education.
10. Morrison, R. N., Boyd, R. N. & Bhattacharjee, S. K. Organic Chemistry, 7 th Ed. PearsonEducation.

PRACTICAL:

1. Yadav, J.B. Advanced Practical Physical Chemistry, Krishna Prakashan.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi.
3. Mendham, J., Denney, R.C., Barnes, J. D., Thomas, M. and Sivasankar, S. Vogel's TextBook of Quantitative Chemical Analysis, 6th Ed., Pearson Education.
4. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, Pearson Education

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PAPER NAME: General Chemistry-I
PAPER CODE: CH-MN-1114
Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 CREDITS

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c) Alkynes: Preparatio*n*- Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra-halides and dehydrohalogenation of vicinal-dihalides. Reactions-formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

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Oxidation-Reduction Titrimetry:

1. Preparation of solutions of different Molarity/Normality of titrants.
2. Estimation of $Fe^{2+}$and Fe^{3+} ions with the help of $K_2Cr_2O_7$and standardized $KMnO_4$ solutions.

Purification methods:

1. Purification of organic compounds by crystallization using the following solvents:
   a) Water
   b) Alcohol
   c) Alcohol-Water
2. Determination of the melting points of recrystallized compounds and unknown organic Compounds.

pH measurements:

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and
   soaps using pH meter.
2. Preparation of buffer solutions:
   (iii)Sodium acetate-acetic acid.
   (iv)Ammonium chloride-ammonium hydroxide.

Surface tension measurement:(in aqueous solutions only).

1. Determination of the surface tension of a dilute solution using astalagmometer.
2. Study of the variation of surface tension of a detergent solution with concentration.

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1. Determination of the relative and absolute viscosity of dilute solution using anOstwald's viscometer.
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3. Atkins, P., Overton, T., Rourke, J., Weller, M. and Armstrong, F., Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
4. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, 9 th Ed., Oxford University Press.
5. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.
6. Negi, A.S., Anand, S.C. A Textbook of Physical Chemistry, 3 rd Ed. New Age International Publishers
7. Silbey, R. J., Alberty, R. A., Bawendi, M. G. Physical Chemistry, 4 th Ed., John Wiley & amp; Sons.
8. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2 nd Ed., Oxford University Press.
9. Bruice, P. Y. Organic Chemistry, 7 th Ed., Pearson Education.
10. Morrison, R. N., Boyd, R. N. & Bhattacharjee, S. K. Organic Chemistry, 7 th Ed. PearsonEducation.

PRACTICAL:

1. Yadav, J.B. Advanced Practical Physical Chemistry, Krishna Prakashan.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi.
3. Mendham, J., Denney, R.C., Barnes, J. D., Thomas, M. and Sivasankar, S. Vogel's TextBook of Quantitative Chemical Analysis, 6th Ed., Pearson Education.
4. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, Pearson Education

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PAPER NAME: Basic Analytical Chemistry-I

PAPER CODE: CH-SE-1113

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY: 2 Credits

TOTAL LECTURES: 30

COURSE OBJECTIVE:

This course aims to familiarize students with different micro and semi-micro analytical techniques and develop the ability to use modern analytical methods for chemical analysis of food, soil, and water.

COURSE OUTCOME:

Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement micro scale and semi-micro experiments, record, interpret and analyze data following scientific methodology.

Unit 1: Introduction to Analytical Chemistry:(7 Lectures)

Concept of sampling, Importance of accuracy, precision and sources of error in analytical measurements, Presentation of experimental data and results.

Unit 2: Analysis of soil: (8 Lectures)

Composition of soil, Concept of pH and pH measurement, Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration, Chelation, Chelating agents, use of indicators.

Unit 3: Analysis of water: (8 Lectures)

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a) Determination of pH, acidity and alkalinity of a water sample.
b) Determination of dissolved oxygen (DO) of a water sample.
c) Determination of salinity, hardness and conductivity of a water sample.

Unit 4: Analysis of food products:(7 Lectures)

Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

PRACTICAL: 1 Credit

TOTAL LECTURES: 30

COURSE OBJECTIVE:

This course aims to give the students practical training to the students on estimation of macro nutrients present in soil by suitable analytical methods. The students will be also get training on handling spectro photometric instruments for the determination of additives and preservatives in food beverages and supplements.

COURSE OUTCOME:

Students will develop skills and expertise in using spectro photometric instruments and learn to determine the concentration of macronutrients in the soil and detect the presence of additives and preservatives in common edible items.

1. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples.
2. Spectro photometric Identification and Determination of Caffeine and Benzoic Acid in
   Soft Drink.
3. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

RECOMMENDED BOOKS:

1. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis* 7thEd., Prentice Hall.
2. Vogel, A. I. Vogel's *Quantitative Chemical Analysis* 6thEd., Prentice Hall.
3. Khopkar, S. M. *Basic Concepts of Analytical Chemistry*, 2nd Ed.
4. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry*, 9th Ed.,Brooks/Cole Cengage Learning.

PAPER NAME: Chemistry in Practical Life-I
PAPER CODE: CH-ID-1113
Total Credits: 3 (Theory)

THEORY

Total Lectures: 45

COURSE OBJECTIVE:

This course aims to familiarize students with the relevance of chemistry in everyday life.

COURSE OUTCOME:

Upon completion of this course, students shall be able to recognize the usefulness of chemistry in daily life.

Unit 1: Some basic concepts of Chemistry: (5 Lectures)

Matter and its classification, Atomic and Molecular mass, Fundamental particles (electron proton, neutron), Atomic number and Mass number, Isotope, Isobar, Isotone, Isotopes of hydrogen

Unit 2: Acid, base and salts:(5 Lectures)

Strong and weak electrolytes, Theories of Acid, Introduction to pH-scale, pH of some common fruits, soft drinks etc.

Unit 3: Water:(8 Lectures)

Water-Hard water and soft water, Removal of hardness of water, water pollution, water purification, Rain-water harvesting.

Unit 4: Energy sources: (5 Lectures)

Primary and Secondary batteries (Lead-acid storage battery, Li-ion battery), Fuel cells, Bio fuels

Unit 5: Molecules of Life:(9 Lectures)

Carbohydrates, Proteins, Vitamins, Nucleic acid (DNA and RNA)

Unit 6: Polymers:(8 Lectures)

Classification of polymers, Some important polymer and its uses-Polyethene, Teflon, PVC, Polyester, Nylon, Rubber, Bakelite, Biodegradable polymers.

Unit 7: Chemistry in Everyday Life:(5 Lectures)

Drugs and it classification, Artificial sweeteners, Food preservatives, Soaps and detergents.

SECOND SEMESTER

PAPER NAME: General Chemistry-II

PAPER CODE: CH-CE-2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 Credits

TOTAL LECTURES: 45

COURSE OBJECTIVE:

This course aims at giving students theoretical understanding about the structure and bonding of molecules, with important concepts like Valence Bond theory and Molecular Orbital theory. The students are introduced to the chemistry of the d-block transition elements including their properties and reactivities. The course also apprises students with introduction to aromatic organic compounds, with special focus on benzene, its properties and reactivity. The students are also introduced to the stereochemistry of organic compounds. Further, the course strives to educate the students on fundamental topic of states of matter- solid state and the important concept of chemical thermodynamics and thermo chemistry.

COURSE OUTCOME:

On successful completion, students would have clear understanding of molecular structure and chemical bonding armed with the important concepts of molecular orbital theory and valence bond theory. Students are expected to identify aromatic compounds and describe their reactivity. The students will also learn the basics of stereochemistry essential for understanding organic chemistry. The students would be introduced to the elementary idea of symmetry which will be useful to understand solid state chemistry and group theory in some higher courses. The students will learn the basic solid state chemistry application of x-ray crystallography for the determination of some very simple crystal structures.

Unit 1: Inorganic Chemistry

Chemical Bonding – I:(3 Lectures)

(i) lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals.

(ii) Covalent bond: Lewis structure, Formal charge.

(iii) Concepts of hybridization involving *s, p* &*d* orbitals, equivalent and non-equivalent hybridorbitals. Bent's rule.

Chemical Bonding – II: (6 Lectures)

(i) Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

(ii) Molecular orbital theory, Molecular orbital diagrams of diatomic and simple polyatomic
molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions.

Transition Elements (3d series):(6 Lectures)

General group trends with special reference to electronic configuration, variable valency, colour,
magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Unit 2: Organic Chemistry

Aromatic Hydrocarbons:(5 Lectures)

Structure and Bonding (Benzene); Hückel's rule of aromaticity, Aromatic character of arenes and heterocyclic compounds with suitable examples. Preparation (of benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid; Reactivity (of benzene): Electrophilic aromatic substitution– nitration, halogenation and sulphonation; Directing effects of the groups. Friedel-Craft's reaction (alkylation and acylation).

Stereochemistry of Organic Compounds: (10 Lectures)

Concept of isomerism, Elementary idea of structural projections: Flying wedge, Newmann, Sawhorse and Fischer representations.
Configurational isomers: Optical isomerism–Optical activity, Concept of chirality; Enantiomers, Diastereomers and Meso compounds; Optically active molecules without chiral centre, Atropisomerism. Racemic Mixtures and Resolution. Geometrical isomerism–*cis-trans* and *syn-anti* isomerism. Relative and absolute configuration with CIP rules: D/L and R/S designations (for upto 2 chiral carbon atoms) and E/Z designations (for upto two C=C systems).

Unit 3: Physical Chemistry

Solids:(4 Lectures)

Symmetry elements, unit cells, crystal systems, Bravais Lattice types and identification of lattice planes. Structure of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals. Glasses and liquid crystals.

Chemical Thermodynamics:(6 Lectures)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.
First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.
Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.
Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Thermochemistry: (5 Lectures)

Important principles and definitions of thermo chemistry. Concept of standard state andstandard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermo chemical data. Variation of enthalpy of a reaction with temperature–Kirchhoff's equation. Adiabatic flame temperature, explosion.

PRACTICAL: 1 credit

Total Lectures: 30

COURSE OBJECTIVE:

This course aims to give the students practical training and sessions to the students on preparation of standard solutions in different concentration and volumetric estimations by acid base reaction. The students will be apprised with chromatographic separation technique of organic compounds. The students will also get sessions on heat capacity and enthalpy measurements of various solutions.

COURSE OUTCOME:

Students will have hands on experience of standard solution preparation in different concentration units and learn volumetric estimation through acid-base reactions. The students will learn to separate and isolate organic compounds by chromatography. The students will be able to measure heat capacities and enthalpies of different solutions.

Acid-Base Titrations

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture
3. Estimation of free alkali present in different soaps/detergents.

Separation techniques

1. Separation of a binary mixture of organic compounds by thin layer chromatography (TLC) like ortho-/para-nitrophenols, ortho-/para-nitroaniline, etc.
2. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

Heat Capacity & Enthalpy measurements

1. Determination of heat capacity of a calorimeter using hot and cold water.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of hydration of copper sulphate.
4. Study of the solubility of benzoic acid in water and determination of ΔH.

RECOMMENDED BOOKS:

THEORY:

1. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Ed., Pearson Education India.
2. Miesslar, G. L. and Tarr, D. A. *Inorganic Chemistry*, 3rd Ed., Pearson Education India.
3. Atkins, P., Overton, T., Rourke, J., Weller, M. and Armstrong, F., *Shriver and Atkins Inorganic Chemistry*, 5th Edition, Oxford University Press.
4. Finar, I. L. *Organic Chemistry (Volume 1)*, 6th Ed. Revised, Pearson Education.
5. Eliel, E. L. &Wilen, S. H. *Stereochemistry of Organic Compounds*, Student Ed.,Wiley
6. Nasipuri, D. *Stereochemistry of Organic Compounds: Principles and Applications*, 4th Ed., New Age International Publishers.
7. Peter, A. and Paula, J. de. *Physical Chemistry*,9th Ed., Oxford University Press.
8. Castellan, G. W. *Physical Chemistry*,4th Ed., Wesley Publishing.
9. Puri, B. R.; Sharma, L. R.; Pathania, M. S. *Principles of Physical Chemistry*, 47thEd. Vishal Publishing Co.
10. Kapoor, K. L. *A Textbook of Physical Chemistry(Volume 2)*, 6th Ed. McGraw Hill Education.

PRACTICAL:

1. Yadav, J.B. *Advanced Practical Physical Chemistry*, Krishna Prakashan.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi.
3. Mendham, J., Denney, R.C., Barnes, J. D., Thomas, M. and Sivasankar, S.*Vogel's Text Book of Quantitative Chemical Analysis*, 6th Ed., Pearson Education.
4. Vogel, A. I. *Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis*, Pearson Education.

PAPER NAME: General Chemistry-II

PAPER CODE: CH-MN-2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 Credits

TOTAL LECTURES: 45

COURSE OBJECTIVE:

This course aims at giving students theoretical understanding about the structure and bonding of molecules, with important concepts like Valence Bond theory and Molecular Orbital theory. The students are introduced to the chemistry of the d-block transition elements including their properties and reactivities. The course also apprises students with introduction to aromatic organic compounds, with special focus on benzene, its properties and reactivity. The students are also introduced to the stereochemistry of organic compounds. Further, the course strives to educate the students on fundamental topic of states of matter- solid state and the important concept of chemical thermodynamics and thermochemistry.

COURSE OUTCOME:

On successful completion, students would have clear understanding of molecular structure and chemical bonding armed with the important concepts of molecular orbital theory and valence bond theory. Students are expected to identify aromatic compounds and describe their reactivity. The students will also learn the basics of stereochemistry essential for understanding organic chemistry. The students would be introduced to the elementary idea of symmetry which will be useful to understand solid state chemistry and group theory in some higher courses. The students will learn the basic solid state chemistry application of x-ray crystallography for the determination of some very simple crystal structures.

Unit 1: Inorganic Chemistry

Chemical Bonding – I:(3 Lectures)

(i) lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals.

(ii) Covalent bond: Lewis structure, Formal charge.

(iii) Concepts of hybridization involving *s, p* &*d* orbitals, equivalent and non-equivalent hybrid orbitals. Bent's rule.

Chemical Bonding – II: (6 Lectures)

(i) Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

(ii) Molecular orbital theory, Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions.

Transition Elements (3d series):(6 Lectures)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Unit 2: Organic Chemistry

Aromatic Hydrocarbons:(5 Lectures)

Structure and Bonding (Benzene); Hückel's rule of aromaticity, Aromatic character of arenes and heterocyclic compounds with suitable examples. Preparation (ofbenzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid; Reactivity (of benzene): Electrophilic aromatic substitution– nitration, halogenation and sulphonation; Directing effects of the groups. Friedel-Craft's reaction (alkylation and acylation).

Stereochemistry of Organic Compounds: (10 Lectures)

Concept of isomerism, Elementary idea of structural projections: Flying wedge, Newmann, Sawhorse and Fischer representations.

Configurational isomers: Optical isomerism–Optical activity, Concept of chirality; Enantiomers, Diastereomers and Meso compounds; Optically active molecules without chiral centre,Atropisomerism. Racemic Mixtures and Resolution.Geometrical isomerism–*cis-trans* and *syn-anti* isomerism. Relative and absolute configuration with CIP rules: D/L and R/S designations (for upto 2 chiral carbon atoms) and E/Z designations (for upto two C=C systems).

Unit 3: Physical Chemistry

Solids: (4 Lectures)

Symmetry elements, unit cells, crystal systems, Bravais Lattice types and identification of lattice planes. Structure of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Thermodynamics: (6 Lectures)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

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Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature–Kirchhoff's equation. Adiabatic flame temperature, explosion.

PRACTICAL: 1 credit

Total Lectures: 30

COURSE OBJECTIVE:

This course aims to give the students practical training and sessions to the students on preparation of standard solutions in different concentration and volumetric estimations by acid base reaction. The students will be apprised with chromatographic separation technique of organic compounds. The students will also get sessions on heat capacity and enthalpy measurements of various solutions.

COURSE OUTCOME:

Students will have hands on experience of standard solution preparation in different concentration units and learn volumetric estimation through acid-base reactions. The students will learn to separate and isolate organic compounds by chromatography. The students will be able to measure heat capacities and enthalpies of different solutions.

Acid-Base Titrations

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2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of hydration of copper sulphate.
4. Study of the solubility of benzoic acid in water and determination of ΔH.

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4. Finar, I. L. *Organic Chemistry (Volume 1)*, 6th Ed. Revised, Pearson Education.
5. Eliel, E. L. &Wilen, S. H. *Stereochemistry of Organic Compounds*, Student Ed.,Wiley
6. Nasipuri, D. *Stereochemistry of Organic Compounds: Principles and Applications*, 4th Ed., New Age International Publishers.
7. Peter, A. and Paula, J. de. *Physical Chemistry*,9th Ed., Oxford University Press.
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10. Kapoor, K. L. *A Textbook of Physical Chemistry(Volume 2)*, 6th Ed. McGraw Hill Education.

PRACTICAL:

1. Yadav, J.B. *Advanced Practical Physical Chemistry*, Krishna Prakashan.
2. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi.
3. Mendham, J., Denney, R.C., Barnes, J. D., Thomas, M. and Sivasankar, S.*Vogel's Text Book of Quantitative Chemical Analysis*, 6th Ed., Pearson Education.
4. Vogel, A. I. *Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis*, Pearson Education.

PAPER NAME: Basic Analytical Chemistry-II

PAPER CODE: CH-SE-2113

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY: 2 Credits

Total Lectures: 30

COURSE OBJECTIVE:

This course aims to educate students on various chromatographic separation techniques utilized during micro and semi-micro analysis. The students will also learn about advanced chromatographic techniques and modern analytical methods for chemical analysis of cosmetics.

COURSE OUTCOME:

Upon completion of this course, students shall have the basic understanding of chromatographic techniques like paper chromatography, thin layer chromatography and column chromatography. The students will be able to identify and analyse the various constituents present in cosmetics.

Unit 1: Chromatography:(8 Lectures)

Definition, general introduction on principles of chromatography, paper chromatography, Thin layer chromatography, etc.

a) Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$and Al^{3+}).
b) To compare paint samples by TLC method.

Unit 2: Ion-exchange: (7 Lectures)

Column chromatography, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Unit 3: Analysis of cosmetics: (15 Lectures)

Major and minor constituents and their function

a) Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b) Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

PRACTICAL: 1 Credit

Total Lectures: 30

COURSE OBJECTIVE:

This course aims to give the students practical training on use of chromatography in real-life trap cases as well as separation of metal mixtures. The students will be also be apprised on semi-micro analysis of common cosmetics.

COURSE OUTCOME:

Students will develop skills and expertise in using chromatographic techniques and learn to separate the components of a given mixture and detect the presence of metals ions in common cosmetic items.

1. To study the use of phenolphthalein in traps cases.
2. Separation of a mixture of metal ions by paper chromatography.
3. Separation of a mixture of organic compounds by thin layer or column chromatography.
4. Estimation of constituents in cosmetics: Zinc, Calcium, Magnesium in talcum powder.

RECOMMENDED BOOKS:

1. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis* 7th Ed., Prentice Hall.
2. Vogel, A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Prentice Hall.
3. Khopkar, S. M. *Basic Concepts of Analytical Chemistry*, 2nd Ed.
4. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry*, 9th Ed.,Brooks/Cole Cengage Learning.

PAPER NAME: Chemistry in Practical Life-II

PAPER CODE: CH-ID-2113

Total Credits: 3 (THEORY)

Total Lectures: 45

COURSE OBJECTIVE:

This course aims to familiarize students with the relevance of chemistry in everyday life.

COURSE OUTCOME:

Upon completion of this course, students shall be able to recognize the usefulness of chemistry in daily life.

Unit 1: Enzymes and Catalysis: (5 Lectures)

Homogeneous and Heterogeneous catalysis, Enzymes, Catalyst, Inhibitor, Poison.

Unit 2: Ores and Alloys:(5 Lectures)

Ores and its types, Alloys and its uses.

Unit 3: Introduction to elements:(7 Lectures)

Groups, Periods, Metals, Non-metals and Metalloids, Uses of some elements in day today life (Sodium, Silver, Gold, Platinum, Copper, Tin, Magnesium, Iron etc.), Adverse effect of some elements (Arsenic, Fluorine, Cadmium, Lead etc.)

Unit 4: Hydrocarbon:(7 Lectures)

Introduction to Alkane, Alkene, Alkyne.Aromatic hydrocarbon-benzene, Introduction to petrol, diesel, kersone, naptha, coal tar, CNG, LPG, PNG etc.

Unit 5: Solid State:(4 Lectures)

Crystalline and Amorphous, Conductor and Insulator, Magnetic properties (Diamagnetic and paramagnetic).

Unit 6: Solution:(4 Lectures)

Types of solution-Homogeneous and Heterogeneous, Solubility of gas in liquid, Osmosis.

Unit 7: Environmental Chemistry:(6 Lectures)

Ozone layer and ozone layer depletion, Green house gases, fog, Acid rain, Air pollution.

Unit 8: Common Chemicals in Daily Life:(7 Lectures)

Bleaching powder, baking soda, ammonium sulfate, plaster of Paris, washing soda, glass, cement etc.