Syllabus for
Four-Year Undergraduate Course
(Chemistry)

(Effective from the Academic Year 2023-24)

Rajiv Gandhi University
Rono Hills, Doimukh
Arunachal Pradesh-791112

2023

19/06/2023
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Major (Core) Course

19/06/2023
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

SEMESTER I

Title of the Course	: General Chemistry I
Course Code	: CHE-CC-1110
Nature of the Course	: Major (Core)
Total Credits	: 4 (L 3 – T 0 – P 1)
Total Contact Hours (CH)	: 75 (Theory – 45; Practical – 30)
Distribution of Marks	: 80 (End Sem) + 20 (In-Sem)

Course Objectives

The course reviews the structure of the atom, which is a necessary prerequisite to understand the nature of chemical bonding in compounds. It is also designed to revisit the fundamental concepts of organic chemistry in detail so that the students can acquire the necessary foundation for a better understanding of other organic chemistry topics in subsequent semesters. The course further covers the basic and advanced concepts regarding gaseous states of matter. It deals with various mathematical equations that express different physical properties of gases. The course also gives an insight into the laboratory courses involving acid-base and redox titrations.

Learning Outcomes

On completion of this course, the students will be able to:

1. Understand the quantum mechanical model of atoms, quantum numbers, electronic configuration, radial and angular distribution curves,and shapes of *s*, *p*, and *d* orbitals.
2. Understand the role of various electronic factors (such as inductive, electromeric, resonance and mesomeric effects) in various physical and chemical properties like stability, polarity, acidity, basicity etc. of different organic species of both neutral and charged in nature.
3. Have a clear idea of aromaticity and its influence in acidity & basicity, stability and reaction kinetics.
4. Acquire knowledge on methods of determination of organic reaction mechanism, kinetically and thermodynamically controlled products and reactions.
5. Understand the differences between ideal and real gases, to derive the kinetic gas equation, deviation from ideal behaviour and reason thereof.
6. Estimate metal contents in different samples using acid-base and redox titration techniques.

Atomic Structure

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 ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals.

Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

(CH: 15)

Conceptual Organic Chemistry

Review of basic concepts: inductive effect, electromeric effect, resonance effect, hyperconjugation. Aromaticity: Huckel's rule, aromatic, non-aromatic, antiaromatic,

homoaromatic compounds, *n*-annulenes. Applications of concept of aromaticity: acidity & basicity, stability, reaction kinetics. Effect of magnetism on aromaticity.
Reaction mechanisms: thermodynamic and kinetic requirement of reactions, Hammond postulate, intermediate and transition states, kinetically and thermodynamically controlled products and reactions, methods of determination of mechanism, primary and secondary kinetic isotope effect.

(CH: 15)

States of Matter I

Kinetic Molecular Model of a Gas: Postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.
Behaviour of Real Gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, introduction of equations of state; virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(CH: 15)

Practical: General Chemistry I

1. Acid-Base Titrations
   (a) Determination of alkali content of antacid tablets using HCl.
   (b) Estimation of calcium content in chalk as calcium oxalate.
   (c) Estimation of carbonate and hydroxide present together in mixture.
   (d) Estimation of carbonate and bicarbonate present together in a mixture.
   (e) Estimation of free alkali present in different soaps/detergents
2. Oxidation-Reduction Titrations
   (a) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
   (b) Estimation of oxalic acid and sodium oxalate in a given mixture.
   (c) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

(CH: 30)

Recommended Books

Theory

1. Lee, J. D., *Concise Inorganic Chemistry*, 5th Ed., Wiley India (2008).
2. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., *Inorganic Chemistry: Principles of Structures and Reactivity*, 4th Ed., Pearson Education India (2006).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., *Shriver Atkins' Inorganic Chemistry*, 6th Ed., Oxford University Press India (2015).
4. Puri, B. R.; Sharma, L. R.; Kalia, K. C., *Principles of Inorganic Chemistry*, 33rd Ed., Vishal Publishing (2017).
5. Sykes, P., *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education India (2003).
6. Kalsi, P.S., *Organic Reactions and Their Mechanisms, 3rd Ed.,* New Age Science (2010).
7. Smith, M. B.; March, J., *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*, 7th Ed., Wiley India (2015).

8. Greeves, N.; Clayden, J.; Warren, S., *Organic Chemistry*, 2nd Ed., Oxford University Press, New Delhi (2012).
9. Atkins, P. W.; de Paula, J.; Keeler, J., *Physical Chemistry,* 11th Ed., Oxford University Press India (2018).
10. Puri, B. R.; Sharma, L. R.; Pathania, M. S., *Principles of Physical Chemistry*, 47th Ed., Vishal Publishing (2017).
11. Kapoor, K. L., *A Textbook of Physical Chemistry: States of Matter and Ions in Solution*, Vol. I, 6th Ed., McGraw Hill Education India (2019).
12. Bahl, A.; Bahl, B. S.; Tuli, G. D., *Essentials of Physical Chemistry*, S. Chand and Company (2014).

Practical

1. Raj, G., *Advanced Practical Inorganic Chemistry*, Krishna Prakashan, Meerut (2013).
2. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., *Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson Education India (2009).

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Rono Hills, Doimukh (A.P.)

SEMESTER II

Title of the Course	: General Chemistry II
Course Code	: CHE-CC-1120
Nature of the Course	: Major (Core)
Total Credits	: 4 (L 3 – T 0 – P 1)
Total Contact Hours (CH)	: 75 (Theory – 45; Practical – 30)
Distribution of Marks	: 80 (End Sem) + 20 (In-Sem)

Course Objectives

The course introduces students to *s*-, *p*-block elements & compounds thereof. Stereochemistry is introduced to visualize organic molecules in a three-dimensional space. The course is also aimed to provide perceptions on various mathematical equations that express different physical properties of gases, liquids and solids.

Learning Outcomes

On completion of this course, the students will be able to:

1. Understand the relative stability of different oxidation states of *s*- & p-block elements and their complex formation behaviour.
2. Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides.
3. Draw three-dimensional molecules in two-dimensional planes using different projection formulae.
4. Understand the optical activity of organic compounds and optical isomerism.
5. Do a conformational analysis of simple acyclic and cyclic organic molecules.
6. Evaluate molecular velocities (average, root mean square and most probable) and average kinetic energy of gases.
7. Derive mathematical expressions for different properties of gas, liquid and solids and to understand their physical significances.

Chemistry of *s*-, *p*-block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.

(a) Boron: Boric acid and borates, boron nitrides, borohydrides (diborane).
(b) Carbon: Types of carbide, CaC_2, SiC, Al_4C_3- preparation, properties and uses
(c) Silicon: Silanes, silicon halides.
(d) Nitrogen & Phosphorus: ammonia-manufacture (Haber's process), Oxides and oxoacids of nitrogen and phosphorus.
(e) Sulphur: Sulphuric acid and its properties as dehydrating agent, oxidizing property and action on metals and non-metals. Peroxo acids of sulphur.
(f) Halogen: Basic properties of halogens, interhalogen compounds, polyhalide ions, pseudohalogens.

(CH: 15)

Stereochemistry I

Stereoisomerism in organic compounds. Constitutional, conformational and configurational isomers. Optical activity & isomerism. Homomers, enantiomers, diastereomers. Chiral centres. Projection formulae and interconversion. Chiral axis and chiral planes, helical chirality. Conformational analysis of simple cyclic & acyclic systems. Optical purity. Atropisomerism.

(CH: 15)

States of Matter II

Gaseous Sate: Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Liquid State: Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

Solid State: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law. Defects in crystals.

(CH: 15)

Practical: General Chemistry II

1. Surface tension measurements.
   (a) Determine the surface tension by drop number method.
   (b) Study the variation of surface tension of detergent solutions with concentration.
2. Viscosity measurement using Ostwald's viscometer.
   (a) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
   (b) Study the variation of viscosity of sucrose solution with the concentration of solute.
3. Determination of water of crystallization.

(CH: 30)

Recommended Books

Theory

1. Lee, J. D., *Concise Inorganic Chemistry*, 5th Ed., Wiley India (2008).
2. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., *Inorganic Chemistry: Principles of Structures and Reactivity*, 4th Ed., Pearson Education India (2006).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., *Shriver Atkins' Inorganic Chemistry*, 6th Ed., Oxford University Press India (2015).
4. Housecroft, C. E; Sharpe, A. G., *Inorganic Chemistry*, 5th Ed., Pearson Education (2018).
5. Sykes, P., *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education India (2003).
6. Smith, M. B.; March, J., *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*, 7th Ed., Wiley India (2015).
7. Sengupta, S., *Basic Stereochemistry of Organic Molecules*, 2nd Ed., Oxford University Press India (2018).

8. Atkins, P. W.; de Paula, J.; Keeler, J., *Physical Chemistry,* 11th Ed., Oxford University Press India (2018).
9. Puri, B. R.; Sharma, L. R.; Pathania, M. S., *Principles of Physical Chemistry*, 47th Ed., Vishal Publishing (2017).
10. Kapoor, K. L., *A Textbook of Physical Chemistry: States of Matter and Ions in Solution*, Vol. I, 6th Ed., McGraw Hill Education India (2019).
11. Bahl, A.; Bahl, B. S.; Tuli, G. D., *Essentials of Physical Chemistry*, S. Chand and Company (2014).

Practical
1. Viswanathan, B.; Raghavan, P. S., *Practical Physical Chemistry*, Viva Books India (2014).
2. Yadav, J. B., *Advanced Practical Physical Chemistry*, Krishna Prakashan, Meerut (2015).

Minor Stream Course

SEMESTER I

Title of the Course	: Fundamental of Chemistry I
Course Code	: CHE-MC-1110
Nature of the Course	: Minor Stream
Total Credits	: 4 (L 3 – T 0 – P 1)
Total Contact Hours (CH)	: 75 (Theory – 45; Practical – 30)
Distribution of Marks	: 80 (End Sem) + 20 (In-Sem)

Course Objectives

The course reviews the structure of the atom, which is a necessary prerequisite to understand the nature of chemical bonding in compounds. It is also designed to revisit the fundamental concepts of organic chemistry in detail so that the students can acquire the necessary foundation for a better understanding of other organic chemistry topics in subsequent semesters. The course further covers the basic and advanced concepts regarding gaseous states of matter. It deals with various mathematical equations that express different physical properties of gases. The course also gives an insight into the laboratory courses involving acid-base and redox titrations.

Learning Outcomes

On completion of this course, the students will be able to:

1. Understand quantum mechanical model of atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of *s*, *p*, and *d* orbitals.
2. Understand the role of various electronic factors (such as inductive, electromeric, resonance and mesomeric effects) in various physical and chemical properties like stability, polarity, acidity, basicity etc. of different organic species of both neutral and charged in nature.
3. Have clear idea on aromaticity and its influence in acidity & basicity, stability and in reaction kinetics.
4. Acquire knowledge on methods of determination of organic reaction mechanism, kinetically and thermodynamically controlled products and reactions.
5. Understand the differences between ideal and real gases, to derive the kinetic gas equation, deviation from ideal behaviour and reason thereof.
6. Estimate metal contents in different samples using acid-base and redox titration techniques.

Atomic Structure

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 ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals.

Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

(CH: 15)

Conceptual Organic Chemistry

Review of basic concepts: inductive effect, electromeric effect, resonance effect, hyperconjugation. Aromaticity: Huckel's rule, aromatic, non-aromatic, antiaromatic,

homoaromatic compounds, *n*-annulenes. Applications of concept of aromaticity: acidity & basicity, stability, reaction kinetics. Effect of magnetism on aromaticity.
Applications of acid-base concept: HSAB and its applications.
Review of reaction mechanisms: thermodynamic and kinetic requirement of reactions, Hammond postulate, intermediate and transition states, kinetically and thermodynamically controlled products and reactions, methods of determination of mechanism, primary and secondary kinetic isotope effect.

(CH: 15)

States of Matter I

Kinetic Molecular Model of a Gas: Postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.
Behaviour of Real Gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, introduction of equations of state; virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(CH: 15)

Practical: Fundamental of Chemistry I

1. Acid-Base Titrations
   (f) Determination of alkali content of antacid tablets using HCl.
   (g) Estimation of calcium content in chalk as calcium oxalate.
   (h) Estimation of carbonate and hydroxide present together in mixture.
   (i) Estimation of carbonate and bicarbonate present together in a mixture.
   (j) Estimation of free alkali present in different soaps/detergents
2. Oxidation-Reduction Titrations
   (d) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
   (e) Estimation of oxalic acid and sodium oxalate in a given mixture.
   (f) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

(CH: 30)

Recommended Books

Theory

1. Lee, J. D., *Concise Inorganic Chemistry*, 5th Ed., Wiley India (2008).
2. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., *Inorganic Chemistry: Principles of Structures and Reactivity*, 4th Ed., Pearson Education India (2006).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., *Shriver Atkins's Inorganic Chemistry*, 6th Ed., Oxford University Press India (2015).
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5. Sykes, P., *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education India (2003).
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Practical

1. Raj, G., *Advanced Practical Inorganic Chemistry*, Krishna Prakashan, Meerut (2013).
2. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., *Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson Education India (2009).

SEMESTER II

Title of the Course	: Fundamental of Chemistry II
Course Code	: CHE-MC-1120
Nature of the Course	: Minor Stream
Total Credits	: 4 (L 3 – T 0 – P 1)
Total Contact Hours (CH)	: 75 (Theory – 45; Practical – 30)
Distribution of Marks	: 80 (End Sem) + 20 (In-Sem)

Course Objectives

The course introduces students to *s*-, *p*-block elements & compounds thereof. Stereochemistry is introduced to visualize organic molecules in a three-dimensional space. The course is also aimed to provide perceptions on various mathematical equations that express different physical properties of gases, liquids and solids.

Learning Outcomes

On completion of this course, the students will be able to:

1. Understand the relative stability of different oxidation states of *s*- & p-block elements and their complex formation behaviour.
2. Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides.
3. Draw three-dimensional molecules in two-dimensional planes using different projection formulae.
4. Understand the optical activity of organic compounds and optical isomerism.
5. Do a conformational analysis of simple acyclic and cyclic organic molecules.
6. Evaluate molecular velocities (average, root mean square and most probable) and average kinetic energy of gases.
7. Derive mathematical expressions for different properties of gas, liquid and solids and to understand their physical significances.

Chemistry of *s*-, *p*-block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.

(a) Boron: Boric acid and borates, boron nitrides, borohydrides (diborane).
(b) Carbon: Types of carbide, CaC_2, SiC, Al_4C_3- preparation, properties and uses
(c) Silicon: Silanes, silicon halides.
(d) Nitrogen & Phosphorus: ammonia-manufacture (Haber's process), Oxides and oxoacids of nitrogen and phosphorus.
(e) Sulphur: Sulphuric acid and its properties as dehydrating agent, oxidizing property and action on metals and non-metals. Peroxo acids of sulphur.
(f) Halogen: Basic properties of halogens interhalogen compounds, polyhalide ions, pseudohalogens.

(CH: 15)

Basic stereochemistry

Stereoisomerism in organic compounds. Constitutional, conformational and configurational isomers. Optical activity & isomerism. Stereoisomerism in organic compounds. Homomers, enantiomers, diastereomers. Chiral centres. Projection formulae and interconversion. Chiral axis and chiral planes, helical chirality. Conformational analysis of simple cyclic & acyclic systems. Optical purity. Atropisomerism.

(CH: 15)

States of Matter II

Gaseous Sate: Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.
Liquid State: Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.
Solid State: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law. Defects in crystals.

(CH: 15)

Practical: General Chemistry II

1. Surface tension measurements.
   (c) Determine the surface tension by drop number method.
   (d) Study the variation of surface tension of detergent solutions with concentration.
2. Viscosity measurement using Ostwald's viscometer.
   (c) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
   (d) Study the variation of viscosity of sucrose solution with the concentration of solute.
3. Determination of water of crystallization.

(CH: 30)

Recommended Books

Theory

1. Lee, J. D., *Concise Inorganic Chemistry*, 5th Ed., Wiley India (2008).
2. Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., *Inorganic Chemistry: Principles of Structures and Reactivity*, 4th Ed., Pearson Education India (2006).
3. Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., *Shriver Atkins' Inorganic Chemistry*, 6th Ed., Oxford University Press India (2015).
4. Housecroft, C. E; Sharpe, A. G., *Inorganic Chemistry*, 5th Ed., Pearson Education (2018).
5. Sykes, P., *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Pearson Education India (2003).
6. Smith, M. B.; March, J., *March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure*, 7th Ed., Wiley India (2015).
7. Sengupta, S., *Basic Stereochemistry of Organic Molecules*, 2nd Ed., Oxford University Press India (2018).

8. Atkins, P. W.; de Paula, J.; Keeler, J., *Physical Chemistry,* 11th Ed., Oxford University Press India (2018).
9. Puri, B. R.; Sharma, L. R.; Pathania, M. S., *Principles of Physical Chemistry*, 47th Ed., Vishal Publishing (2017).
10. Kapoor, K. L., *A Textbook of Physical Chemistry: States of Matter and Ions in Solution*, Vol. I, 6th Ed., McGraw Hill Education India (2019).
11. Bahl, A.; Bahl, B. S.; Tuli, G. D., *Essentials of Physical Chemistry*, S. Chand and Company (2014).

Practical

1. Viswanathan, B.; Raghavan, P. S., *Practical Physical Chemistry*, Viva Books India (2014).
2. Yadav, J. B., *Advanced Practical Physical Chemistry*, Krishna Prakashan, Meerut (2015).

Multidisciplinary Course

Title of the Course	: Chemistry of Food, Cosmetics and Perfumes
Course Code	: CHE-MD-0010
Nature of the Course	: Multidisciplinary
Total Credits	: 3 (L 3 – T 0 – P 0)
Total Contact Hours (CH)	: 45 (Theory – 45; Practical – 0)
Distribution of Marks	: 60 (End Sem) + 15 (In-Sem)

Course Objectives

This course will introduce students to the basic idea of food chemistry, cosmetics and perfumes. The course is designed to provide students with a basic idea of the analysis of food products and cosmetics.

Learning Outcomes

After the completion of the course, the students will:

1. Learn about food processing, food preservation, food additives, contaminants, colourants and adulteration.
2. Learn about analyses of food preservatives and colouring matter.
3. Learn about the constituents of hair shampoo and colourants.
4. Have an idea about the mechanism of action, preparation and manufacture of shampoo.
5. Have an idea about the constituents of deodorants and antiperspirants and their mechanism of action.

Food Preservations, Additives and Contaminants

Food Preservation: The idea of food preservation. Definition. Use of food preservatives: when to use and when not to use food preservatives. Classes of food preservatives and examples with application: benzoates, parabens, propionates, sorbates, sulphites, nitrates and nitrites, and antioxidants. Analysis of preservatives.

Food additives: Definition, intentional additives and incidental additives. Contaminants: heavy metals, toxins, pesticides.

Food flavours: Definition of flavour. Basic taste: sweet, salty, bitter, sour. Areas of taste sensitivity on the tongue. Taste inhibition and modification. Flavour enhancers and artificial sweeteners (Aspartame, saccharin, sucralose, sodium cyclamate and monosodium glutamate).

(CH: 15)

Food Processing, Colourants and Adulteration

Idea about food processing, packaging and adulteration.

Artificial food colourants: Natural and synthetic colourants, Food colourants: tetrapyrrole pigments, chlorophyll, carotenoids, anthocyanins and betalanins. Application of colours in the food industry. Analysis of colouring matter.

Food adulteration: Definition and its importance, adulterants present in- coffee, tea, milk, spices, grains and food colour; Difference between food adulteration and contamination. Identification of adulterants in some common food items. Food Standards: BIS, Agmark, FPO, MPO, PFA, FSSAI.

(CH: 15)

Chemistry of Cosmetics and Perfumes

Hair shampoo: Introduction and action. Shampoo ingredients: main detergents and their classification. A general study on shampoo additives, functional additives and antidandruff agents. Preparation and manufacture of shampoo.

Hair colourant: Introduction, natural pigmentation. Categories of hair colourant: temporary, semipermanent (direct dyes), gradual colourants (auto-oxidative and metallic dyes), natural dyes, demipermanent (oxidation dyes), permanent (oxidation dyes).

Face powder, talcum powder. Lipstick, lip gloss and lip liners. General discussion on nail powders, nail enamel, nail enamel colouring, cream-type enamels, pearlized enamels, enamels with UV absorbers, water-based enamels, enamel removers, and nail extenders.

Antiperspirants and Deodorants antiperspirants: Introduction, first products, antiperspirants vs deodorants, mechanism of antiperspirants.

(CH: 15)

Recommended Books

Theory

1. Srilakshmi, B., *Food Science*, 7th Ed., New Age International, New Delhi (2018).
2. Subhalakshmi, G.; Udipi, S. A., *Food Processing and Preservation*, New Age International, New Delhi (2018).
3. Potter, N. N.; Hotchkiss, J. H., *Food Science*, 5th Ed., Springer (1999).
4. Poucher, W. A., *Poucher's Perfumes, Cosmetics and Soaps*, 10th Ed., Springer (2005)
5. Poornima, B., *Food Science & Quality Control*, 1st Ed., Centrum Press (2014).
6. Gaur, S.C., *A Handbook of Agn. Food processing and marketing*, Agro. Bios India (2012).
7. deMan, M. J.; Finley, J. W.; Hurst, J. W.; Lee, C. Y., *Principles of Food Chemistry*, 4th Ed., Spinger (2018).

Skill Enhancement Course

19/06/2023
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

Title of the Course	: Water Treatment and Analysis
Course Code	: CHE-SE-0010
Nature of the Course	: Skill Enhancement
Total Credits	: 3 (L 1 – T 0 – P 2)
Total Contact Hours (CH)	: 75 (Theory – 15; Practical- 60)
Distribution of Marks	: 60 (End Sem) + 15 (In-Sem)

Course Objectives

The objective of the course is to develop a basic understanding of water quality parameters, and skills required for analysis and purification of water. Given the poor quality of potable water throughout in India, this course is expected to provide required liveskills on water related enterprise and research.

Learning Outcomes

After the completion of the course, the students will be able to:

1. Understand various parameters measured for determining the water quality such as alkalinity, hardness, total dissolved solids etc.
2. Apply knowledge of basic water chemistry to solve problems associated with water/ wastewater treatment and natural water quality
3. Understand various water treatment processes.
4. Learn about hard water, its effect and industrial methods of water softening.
5. Understand various desalination processes for water treatment.
6. Acquire basic practical knowledge for water sample analyses.
7. Analyse water for chemical and biological substances present therein.
8. Determine hardness, dissolved oxygen and TDS of water practically.

Water Quality Parameters and Analysis

Characteristics of water, alkalinity. Hardness: unit of hardness, total solids, oxidation, transparency, silica content. Determination of hardness of water: titration method, complexometric method using EDTA. Expressing hardness: equivalents of calcium carbonate. Problems in determining temporary and permanent hardness.

Analysis of chemical substances affecting health: NH_3, nitrate, nitrite, cyanide, sulphate, sulphide, chloride, fluoride, and arsenic. Measurement of toxic chemical substances, analysis of chemical substances indicative of pollution, dissolved oxygen, bio chemical oxygen demand (BOD), chemical oxygen demand (COD).

(CH: 8)

Water Purification

Purification of water for drinking purposes: potability of water, clarification, coagulation, contact and electrochemical coagulation, sterilization and disinfection of water, precipitation, aeration, ozonisation, chlorination. Water softening methods: Clark's process, lime soda process, modified lime soda process, permutit or zeolite process, ion exchange process, demineralization of water. Desalination of brackish water: electrodialysis, reverse osmosis, removal of Fe, Mn and silicic acid, effluent treatment of water from paper industry, petrochemical, fertilizer industry and power station.

Hard water and industries, industrial water treatment, boiler feed water method of softening, prevention of plumbosolvency, scales in boilers and consequences, internal conditioning methods.

(CH: 7)

Practical: Water Treatment and Analysis

1. Water analysis: Sampling techniques for water analysis.
2. Preliminary examination: alkalinity (bicarbonate, carbonate, hydroxide, acidity), chloride, nitrate, nitrite, fluoride, sulphate, arsenic, and calcium; temperature, pH and conductivity.
3. Analysis of solids present in water: suspended solids, dissolved solids, free Mg, Fe, Mn, Ag and Zn.
4. Determination of hardness of water.
5. Determination of dissolved oxygen in water.
6. Qualitative determination of toxic substance in water.
7. Determination of chemical oxygen demand (COD).
8. Determination of Biological oxygen demand (BOD).
9. Purification of water by coagulation method.
10. Purification of water by aeration method.
11. Purification of water by ozonization method.
12. Purification of water by chlorination method.
13. Removal of fluoride from water.
14. Removal of heavy metals (arsenic, iron, manganese, lead) from water.

(CH: 60)

Recommended Books

Theory

1. Sharma, B. K., *Industrial Chemistry (including Chemical Engineering)*, Goel Publishing House, Meerut (2000).
2. Varashney, C. K., *Water Pollution and Management*, 2nd Ed, New Age International (2018).
3. Srivastava, A., *Waste Water Treatment and Water Management: Water Treatment and Management*, Notion Press (2018).

Practical

1. APHA, *Standard Methods for the Examination of Water, Sewage and Industrial Wastes*. 20th Ed., American Public Health Association: Washington, USA (1995).

Title of the Course	: Soil Chemistry and Analysis
Course Code	: CHE-SE-0020
Nature of the Course	: Skill Enhancement
Total Credits	: 3 (L 1 – T 0 – P 2)
Total Contact Hours (CH)	: 75 (Theory – 15; Practical- 60)
Distribution of Marks	: 60 (End Sem) + 15 (In-Sem)

Course Objective

The objective of the course is to impart basic knowledge about the physical properties of soil, soil chemistry, soil fertility and different nutrients in soil, fertilizers and pesticides. The students will acquire knowledge on the importance and effect of fertilizer and manure on plant growth. In addition, it aims to impart knowledge on pesticides and their effect on the environment.

Learning Outcomes

After the completion of the course, the students will be able to:

1. Get introduced themselves to various concepts of soil science like soil profile, soil texture, particle density of soil particles, porosity of soils, etc.
2. Understand soil fertility, essential and beneficial elements present in soil as source of plant nutrients, reclamation of soil fertility, etc.
3. Acquire knowledge on different types of fertilizers and manures and their method of production.
4. Understand the effect of fertilizers and insecticides on soil fertility and the method of evaluation of soil fertility.
5. Acquire knowledge on different pesticides, insecticides & herbicide and their adverse effect on the environment.
6. Estimate N, S, P, K content of soils.
7. Estimate the N content of urea practically.
8. Synthesize simple organophosphates, carbamates, etc.

Introduction to Soil Chemistry

Components of soil, soil profile, soil physical properties, soil texture, textural classes, particle size analysis, soil structure, classification, soil aggregates, significance, bulk density and particle density of soils and porosity, their significance and manipulation, soil compaction, soil colour, elementary knowledge of soil classification of India, retention and potentials, soil moisture constants, soil colloids, properties, types and significance, adsorption of ions, ion exchange, CEC and AEC, factors influencing ion exchange and its significance.

Soil as a source of plant nutrients, essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, acid, salt affected and calcareous soils, characteristics, nutrient availabilities, reclamation: mechanical, chemical and biological methods.

Soil organic matter, composition, decomposability, Humus, fractionations of organic matter, carbon cycle, C: N ratio.

Methods of soil testing: chemical methods, critical levels of different nutrients in soil.

(CH: 8)

Soil Fertility, Fertilizers, Manures and Pesticides

Soil fertility: different approaches for soil fertility evaluation.

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Fertilizers: Effect of nitrogen, potassium and phosphorous on plant growth, classification of fertilizers, requisites of good fertilizers, nitrogenous fertilizers, phosphatic fertilizers, superphosphate of lime, triple super phosphate, NPK fertilizers, ill effects of fertilizers, effect of mixed fertilizers on soil pH.
Manures: Organic manures, farmyard manure.
Pesticides: General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

(CH: 7)

Practical: Soil Chemistry and Analysis

1. Soil Analysis
   (a) Collection and processing of soil for analysis.
   (b) Soil texture and mechanical analysis.
   (c) Determination of bulk density and particle density, water holding capacity.
   (d) Estimation of available N, P, K, S and Zn in soils
   (e) Determination of organic carbon, pH and EC (Soluble cations and anions in soil water extracts).
   (f) Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
2. Fertilizer and Pesticide Analysis
   (a) Estimation of available N in Urea and commercial fertilizers.
   (b) Calculation acidity/alkalinity in a given sample of commercial pesticide as per BIS specification.
   (c) Preparation of simple organophosphates and diethyldithiocarbamate.
3. Any suitable/relevant practical may be introduced time to time.

(CH: 60)

Recommended Books

Theory

1. Biswas, T. D.; Mukherjee, S. K., *Text Book of Soil Science*, 2nd Ed., McGraw Hill Publishing Company, New Delhi (2017).
2. Brady, N. C.; Well, R. R., *The Nature and Properties of Soil*, 14th Ed., Pearson Education India (2013).
3. Troch, F. R.; Thompson, L. M., *Soils and Soil Fertility*, Wiley India, New Delhi (2008).
4. Jaiswal, P. C., *Soil, Plant and Water Analysis*, 3rd Ed., Kalyani Publishers: New Delhi (2014).
5. Ghosh, J., *Fundamental Concept of Applied Chemistry*, S. Chand & Company, New Delhi (2010).
6. Cremlyn R., *Pesticide: Preparation and Modes of Action*, John Wiley & Sons, New York (1978).

Practical

1. Sarkar, D.; Haldar, A. *Physical and Chemical Methods in Soil Analysis*, 2nd Ed., New Age International (2010).
2. Saha, A. K. *Methods of Physical and Chemical Analysis of Soil*, Kalyani Publishers (2008).
3. Mendham, J.; Denney, R. C.; Barnes, J. D.; Thomas, M.; Sivasankar, B., *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Ed., Pearson Education, New Delhi (2009).

4. Raj, G., *Advanced Practical Inorganic Chemistry*, Krishna Prakashan, Meerut, Meerut (2013).

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