

Vocational/ Skill Enhancement Course

On

Basic Analytical Chemistry

(Four Semester Course for Undergraduate Students as per NEP-2020)



03 credit course

Offered by:

Department of Chemistry

Sridev Suman Uttarakhand University

Badshahithaul (Tehri-Garhwal)

Vocational/Skill Development Course in Chemistry

Semester I

Course Title: BASIC ANALYTICAL CHEMISTRY-I

Programme/Class: Certificate in Science	Year: First	Semester: First
Theory Subject: Vocational/Skill Development Course		
Course Code	Course Title: BASIC ANALYTICAL CHEMISTRY-I	

Course Objectives: This course is value-based and/or skill-based and is aimed at providing hands-on-training, competencies, skills, etc. This course may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. Basic analytical techniques will be taught in this course.

Course outcomes: After completion of the course, the student shall be able to-

1. Process and represent data with more accuracy & precision.
2. Learn various sampling methods and can work as a sample analyst.
3. Handle different solutions and perform quantitative estimation of samples.

Credits: 03	Elective
Max. Marks: 25 + 75	Min. Passing Marks: 40
Total Number of Hours : 45	

Unit- I: (15 Hrs)

Errors and Statistical Data Handling: Errors - Sources and minimization, significant figures, accuracy and its importance, precision, sensitivity, selectivity, sampling and sample size, presentation of experimental data and results, standard deviation, control chart, confidence limit, test of significance, rejection of a result Q, t, F test

Unit- II: (10 Hrs)

Solution: Solute and solvent, types of solutions, solubility and solubility product, pH and buffer concept, common ion effect, mole concept, concentration terms - percentage, ppm, ppb, g/L, molarity, normality, molality, mole fraction and preparation of solutions.

Unit- III: (06 Hrs)

Volumetric Analysis: Primary standard, acid-base titrations, precipitation titrations (Volhard's and Mohr's), Redox titrations (iodometric and idimetric), complexometric titrations, characteristics of metallochromic indicators.

Unit- IV: (06 Hrs)

Gravimetric Analysis: Supersaturation and nucleation, rate of precipitation, purity of precipitates, co- precipitation, post-precipitation, homogeneous precipitation, organic precipitants, masking agents, acid equilibria.

Unit- V: (8 Hrs):

Hands on training on solution preparation, sampling and presentation of experimental data, titrations, quantitative estimation of metal ions through gravimetric analysis.

Evaluation Method	Marks
Mid-Term Exam/In-class or online test/Home assignments/Group discussions/Oral Presentations	20
Overall performance throughout the semester, Discipline, Participation in different activities & attendance	05

Course Prerequisites: To study this course, a student must be enrolled in B. Sc./B.Com./B.A. I semester.

Reference:

1. Khopkar, S.M. Basic Concepts of Analytical Chemistry New Age, International Publisher, 2009.
2. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
3. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
4. Gupta, Alka L.; Analytical Chemistry, Pragati Prakashan.
5. Vogel, A. I. Vogels Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

Vocational/Skill Development Course in Chemistry
Semester II
Course Title: BASIC ANALYTICAL CHEMISTRY-II

Programme/Class: Certificate in Science	Year: First	Semester: Second
Theory Subject: Vocational/Skill Development Course		
Course Code	Course Title: BASIC ANALYTICAL CHEMISTRY-II	

Course Objectives: This course is value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. This course may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. Basic analytical techniques will be taught in this course.

Course outcomes: After completion of the course, the student shall be able to-

1. Characterize/test various organic/inorganic molecules using different analytical techniques.
2. Analyze various soil, water and food sample along with pollution parameters.
3. Learn various laboratory methods of analysis of various parameters related to environment and can work as an environmental analyst.

Credits: 03	Elective
Max. Marks: 25 + 75	Min. Passing Marks: 40
Total Number of Hours: 45	

Unit- I. (10 Hrs)

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. c. Essential element detection in soil

Unit- II. (12 Hrs)

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Important water quality parameters a. Determination of turbidity, colour, taste, pH, acidity, and alkalinity of a water sample. b. Determination of TDS, toxic metals, total hardness, dissolved oxygen (DO) BOD, COD of a water sample. Standards for drinking water as per BIS specifications.

Unit- III. (5 Hrs)

Pollution: Definition, types of pollution, pollution control measures, types of chemical pollution with examples, four major effects of chemical pollution, chemicals in e-waste and its disposal, toxic effects of chemical pollution.

Unit- IV. (10 Hrs)

Analysis of food products: Nutritional value of foods, idea about food processing and use of food preservatives. Food adulteration and its detection.

- a. Identification of adulterants coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
- b. Analysis of preservatives and colouring matter.

Unit- V. (8 Hrs)

Hands on training through measurement of pH, acidity, concentration of metal ions (Ca^{2+} and Mg^{2+}) of soil and water samples and testing of adulterants through chemical methods.

Evaluation Method	Marks
Mid-Term Exam/In-class or online test/Home assignments/Group discussions/Oral Presentations	20
Overall performance throughout the semester, Discipline, Participation in different activities & attendance	05

Course Prerequisites: To study this course, a student must be enrolled in B. Sc./B.Com./B.A. II semester and studied Basic Analytical Chemistry-I in first semester.

Reference :

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
3. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
4. Gupta, Alka L.; Analytical Chemistry, Pragati Prakashan.
5. Vogel, A. I. Vogels Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

Vocational/Skill Development Course in Chemistry
Semester III
Course Title: BASIC ANALYTICAL CHEMISTRY-III

Programme/Class: Diploma in Science	Year: Second	Semester: Third
Theory Subject: Vocational/Skill Development Course		
Course Code:	Course Title: BASIC ANALYTICAL CHEMISTRY-III	

Course Objectives: This course is value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. This course may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. Basic analytical techniques will be taught in this course.

Course outcomes: After completion of the course, the student shall be able to-

1. Characterize/test various organic/inorganic molecules using different separation techniques.
2. Separate two or more different compounds using various purification analytical techniques and filtration process used in industries.
3. Work in the cosmetic industry and distillation plants and can work as a chemical analyst in biomedical field.

Credits: 03	Elective
Max. Marks: 25 + 75	Min. Passing Marks: 40
Total Number of Hours : 45	

Unit- I. (15 Hrs)

Separation and Purification Techniques:

Bulk Separation- Filtration- filter paper, simple filtration, filtration through vacuum pump. Temperature dependent effects (distillation- types of distillation, simple distillation, fractional distillation, evaporation and drying), solubility effect (solvent extraction, crystallization and precipitation) and ion exchange.

Instrumental Separation- Chromatographic techniques

Definition and general introduction of various chromatographic techniques (paper chromatography, TLC, ion-exchange chromatography, HPLC, GC)

Unit- II. (10 Hrs)

Chemistry of cosmetics: A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours.

Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Unit- III. (5 Hrs)

Analysis of cosmetics: Major and minor constituents of Analysis of cosmetics 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.

Unit IV: (7 Hrs)

Clinical Chemistry: Composition of Blood, Collection, and preservation of samples. Diagnostic test for sugar, salt and cholesterol in serum and urine. Causes, detection, and control of anaemia and diabeties. Indian medicinal plants and uses-Tulsi, Neem, Kizhanelli, Mango, Semparuthi, Adadodai and Thoothvelai.

Unit V: (8 Hrs)

Hands on training through- Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). To compare paint samples by TLC method. Determination of ion exchange capacity of anion / cation exchange resin by batch procedure Preparation of soap, talcum powder, shampoo, enamels, hair remover, face cream nail polish and nail polish remover.

Evaluation Method	Marks
Mid-Term Exam/In-class or online test/Home assignments/Group discussions/Oral Presentations	20
Overall performance throughout the semester, Discipline, Participation in different activities & attendance	05

Course Prerequisites: To study this course, a student must be enrolled in B. Sc./B.Com./B.A. III semester and studied Basic Analytical Chemistry-II in second semester.

Reference :

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog & Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
5. Vogel, A. I. Vogels Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
6. Barel, A.O.; Paye, M.; Maibach, H.I. (2014), Handbook of Cosmetics Science and a Technology, CRC Press.
7. A Text Book of Pharmaceutical Chemistry - Jayashree Ghosh – S. Chand Company Ltd.

Vocational/Skill Development Course in Chemistry
Semester IV
Course Title: Basic Analytical Chemistry-IV

Programme/Class: Diploma in Science	Year: Second	Semester: Fourth
Theory Subject: Vocational/Skill Development Course		
Course Code:	Course Title: Basic Analytical Chemistry-IV	

Course Objectives: Spectroscopy is the demand of the day, this course will make student familiar with different Spectroscopic methods, so the he/she may be able to characterize and identify various compounds that are synthesized in laboratory or isolated from plants or any other source. Basic spectroscopic techniques along with their spectral characterization will be taught in this course.

Course outcomes: After completion of the course, the student shall be able to-

1. Characterize various organic/inorganic molecules using different spectroscopic techniques.
2. Distinguish two different compounds by comparing their various spectroscopic data.
3. Hands on training on some spectroscopic instruments will help to develop industrial exposure.

Credits: 03	Elective
Max. Marks: 25 + 75	Min. Passing Marks:
Total Number of Hours : 45	

UNIT-I: Ultraviolet -Visible absorption spectroscopy: (10 Hrs)

Merits of spectroscopic analysis, Electromagnetic radiation, Wavelength, frequency, wave number and their relation, Absorption spectra, absorbance, Absorption laws- Beers, Lambert Law and Beer-Lambert Law, molar absorptivity, UV spectra, types of electronic transitions, Concept of chromophore and auxochrome, Effect of solvents (polarity) and conjugation on absorption maxima, Bathochromic (Red Shift), hypsochromic (Blue Shift), hyperchromic and hypochromic effect, UV spectra of dienes and Woodward — Fieser Rules.

UNIT-II: Infrared (IR) absorption spectroscopy: (10 Hrs)

Introduction, IR active and in-active molecules, Molecular vibrations - stretching and bending vibrations, Fundamental bands, Vibrational transitions and degree of freedom, Hookes Law, selection rules, intensity and position of IR bands, Factors affecting vibrational frequencies, Fermi resonance, Instrumentation, measurement of IR spectrum, solvents, Functional Groups region, fingerprint region, Characteristic absorptions of various functional groups.

UNIT-III: Nuclear Magnetic Resonance Spectroscopy (NMR): (15 Hrs)

Principle of Proton magnetic resonance spectroscopy, Origin of Signal, Number signals-equivalent and non-equivalent protons, Position of signals - shielding and deshielding of protons, Peak area and proton counting, Chemical shift, units, scales, δ values of different types of protons, factors affecting δ , Splitting of Signals - Spin — Spin Coupling, coupling constants, magnetic equivalence of protons, Applications of NMR Spectroscopy.

UNIT-IV: Atomic Absorption Spectroscopy: (6 Hrs)

Principles, Atomization process- Flame atomization, Electrothermal atomization, atomic line widths and radiation sources for AA, Instrumentation, Interferences, Background correction methods, Merits, demerits, and applications.

UNIT-V: Structure Elucidation: (4 Hrs)

Structure elucidation of organic molecules on the basis of UV-Visible, IR, NMR Spectral data, chemical properties and molecular weight.

Evaluation Method	Marks
Mid-Term Exam/In-class or online test/Home assignments/Group discussions/Oral Presentations	20
Overall performance throughout the semester, Discipline, Participation in different activities & attendance	05

Course Prerequisites: To study this course, a student must be enrolled in B. Sc./B.Com./B.A. IV semester and studied Basic Analytical Chemistry-III in third semester.

References:

1. Morrison, R.T. and Boyd, R.T.; Organic Chemistry, Pearson Education
2. Soloman, Fundamentals of Organic Chemistry, Wiley
3. Dhawan, Organic Chemistry, Vol III, Pradeep Publication
4. Y.R. Sharma, Spectroscopy, S. Chand Co, New Delhi
5. Jagdamba Singh, UGC Organic Chemistry Vol III, Pragati Prakashan , Meerut
6. Jagmohan; Organic Spectroscopy
7. Banwell, C.N., McCash, E.M.; Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill Publishing Company Ltd.