Course Structure for Under-Graduate Programme in Chemistry, 2025

Semester	Course Type	Courses	Course Code	Credits (T+P)	Marks	Internal Assessment	End Semester	
							Theory	Practical
First Semester	DSC-A1	Inorganic Chemistry-I	CHEM-111	3+1	100	30	50	20
	DSC-B1	To be chosen from **(Phys/Maths /Botany/Zoology)**		3+1	100	30	50	20
	MC-1	To be chosen from **(Phys/Maths/Botany/Zoology)**		3+1	100	30	50	20
	MDC 1	Introductory Chemistry-I	CHEM-112	3+0	75	25	50	00
	SEC 1	Basic Analytical Chemistry-I	CHEM-113	3+0	75	25	50	00
	AEC1	To be chosen from language course		2+0	50	15	35	00
Second Semester	DSC-A2	Organic Chemistry-I	CHEM-121	3+1	100	30	50	20
	DSC-B2	To be chosen from **(Phys/Maths/Botany/Zoology)**		3+1	100	30	50	20
	MC-2	To be chosen from **(Phys/Maths/Botany/Zoology)**		3+1	100	30	50	20
	MDC 2	Introductory Chemistry-II	CHEM-122	3+0	75	25	50	00
	SEC 2	Basic Analytical Chemistry-II	CHEM-123	3+0	75	25	50	00
	I/A/P/C	Internship/Apprenticeship/Project /Community Outreach	-	4+0	100	-	-	-
	Value Added Course (VAC)	As proposed by Department of Environmental Science	-	2+0	50	15	35	00

DSC offered by the Chemistry discipline will be treated Minor course for other disciplines

SKILL ENHANCEMENT COURSE (SEC)
SEMESTER-I
CHEM-SEC-113TH
Basic Analytical Chemistry-I

Max. Marks: 50 **Time Allowed: 2 Hours**
Credits: 3
Note for Examiners and Students:

• There shall be three Sections/Blocks (I, II, III) in each course • Each Sections/Blocks preferably, may have 3 units.	• There shall be Continuous and Comprehensive Evaluation (CCE). • Each Paper in a Course shall be of 75 marks and divided as follows: Internal Assessment -25 Marks End-Semester Exam -50 Marks • **Internal Assessment:** Attendance -05 Marks Class Test -10 Marks ***The Internal Assessment of Practical component will be of as follows:** • Lab CCA (Performance + Assignment in the form of Practical File) -10 Marks	There will be 4 Parts (A, B,C,D) and examiner shall set 7 questions in total from all the Sections/Blocks (I,II,III) of the syllabus in total. • Part A will have 2 questions of 12 Marks each from Section/Block I of the syllabus and students have to attempt any one. • Part B will have 2 questions of 12 Marks each from Section/Block II of the syllabus and students have to attempt any one. • Part C will have 2 questions of 12 Marks each from Section/Block III of the syllabus and students have to attempt any one. • Part D will have 10 short answer questions of 2 Marks each from all the three Sections/Blocks (I, II, III) of the syllabus and student have to attempt 7 in total.

NOTE: Pass marks of each subject: 40% Aggregate and minimum 35% in each individual component (term end exams, practical, IA, etc.) of a subject.

***Instructions for Practical component of Skill Enhancement Course (SEC):**

- The teacher concerned will ensure that all the experiments mentioned in the Practical component of Skill Enhancement Course (SEC) be conducted.
- The students need to prepare a separate Practical file after performing all the experiments of the Practical component of Skill Enhancement Course (SEC) in the laboratory.
- The evaluation of practical component of 10 Marks will be made internally by the teacher concerned.
- There will be no End Semester Examination for practical component of SEC.
- The Internal Assessment of Practical component will be of as follows:

  Lab CCA (Performance + Assignment in the form of Practical File) -10 marks

Course Objectives:

- Develop a solid understanding of the basics of analytical chemistry, presentation of analytical data, errors in analysis, and concepts of chemical analysis of water along with determination of various parameters of water.
- To have a comprehensive knowledge of processing and preservations of food with special emphasis on adulteration in some common foods and analysis of food preservatives and colors.
- Determine the composition and pH of soil, to use complexometric titrations for estimation of ions present in soil.
- Understand the fundamentals and mechanism of solvent extraction with special emphasis on some techniques of solvent extractions.
- To estimate Fe(II) and Cu (II) by titrimetry and to determine refractive indices of some liquids.

Learning Outcomes: Upon completing the course, students will be able to:

- Know the basic concepts of analytical chemistry including, concept of sampling, errors during analysis, and presentation of experimental data/results.
- Understand various methods of processing and preserving food along with various adulterants in some common food items and their analysis.
- To know composition and determination of pH of soil and estimation of some ions in soil by complexometry.
- Apply various qualitative and quantitative aspects of solvent extraction for metal ions and organic species along with a few techniques of extraction
- To determine the %age of Fe(II) and Cu (II) by titrations with $K_2Cr_2O_7$ and $Na_2S_2O_3$, respectively, and to measure refractive indices of pure solvents.

SECTION –A

Introduction to Analytical Chemistry
Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of water: 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.

SECTION –B

Analysis of food products

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.

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.

SECTION –C

Solvent Extraction

Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media. Techniques of extraction: batch, continuous and counter current extractions. Stereo isomeric separation and analysis: Measurement of optical rotation, calculation of enantiomeric excess (ee)/ diastereomeric excess (de).

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A., Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

PRACTICAL COMPONENT OF SKILL ENHANCEMENT COURSE (SEC)
(SEMESTER I)
Basic Analytical Chemistry-I

1. Estimation of number of molecules of water of crystallization in Mohr's salt by titrating with $K_2Cr_2O_7$.
2. Estimation of percentage of Fe (II) ions in green vitriol by titrating it with $K_2Cr_2O_7$.
3. Estimation of Cu (II) ions iodometrically using sodium thiosulphate solution ($Na_2S_2O_3$).
4. Refractive Index (R_I) Measurements:
   (i) Refractive index measurements of pure solvents
   (ii) Analysis of solvent mixtures in terms of composition from the calibration plot

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. G. Raj, Advanced Physical Chemistry, Practical Handbook, , Edition (2016)
4. Yadav, J.B., Advanced Practical Physical Chemistry, Handbook, Edition (2016)

SKILL ENHANCEMENT COURSE (SEC)
SEMESTER-II
CHEM-SEC-123TH
Basic Analytical Chemistry-II

Max. Marks: 50 **Time Allowed: 2 Hours**
Credits: 3
Note for Examiners and Students:

• There shall be three Sections/Blocks (I, II, III) in each paper • Each Sections/Blocks preferably, may have 3 units.	• There shall be Continuous and Comprehensive Evaluation (CCE). • Each Paper in a Course shall be of 75 Marks and divided as follows: Internal Assessment -25 Marks End-Semester Exam -50 Marks • **Internal Assessment:** Attendance -05 Marks Class Test -10 Marks ***The Internal Assessment of Practical component will be of as follows:** • Lab CCA (Performance + Assignment in the form of Practical File) -10 Marks	There will be 4 Parts (A, B, C, D) and examiner shall set 7 questions in total from all the Sections/Blocks (I, II, III) of the syllabus in total. • Part A will have 2 questions of 12 Marks each from Section/Block I of the syllabus and students have to attempt any one. • Part B will have 2 questions of 12 Marks each from Section/Block II of the syllabus and students have to attempt any one. • Part C will have 2 questions of 12 Marks each from Section/Block III of the syllabus and students have to attempt any one. • Part D will have 10 short answer questions of 2 Marks each from all the three Sections/Blocks (I, II, III) of the syllabus and student have to attempt 7 in total.

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- The evaluation of practical component of 10 Marks will be made internally by the teacher concerned.
- There will be no End Semester Examination for practical component of SEC.
- The Internal Assessment of Practical component will be of as follows:

  Lab CCA (Performance + Assignment in the form of Practical File) -10 marks

Course Objectives:

- Develop a solid understanding of the principles, qualitative and quantitative aspects of various chromatographic methods with special emphasis on paper chromatography.
- To have a comprehensive knowledge of various chromatographic techniques, such as thin layer, column, ion exchange, gas chromatography, and HPLC.
- To have an in depth knowledge of gravimetric and volumetric analysis with special emphasis on volumetric titrimetry, gravimetric titrimetry, and coulometric titrimetry.
- To give hands on exposure for separation of a mixture by paper chromatography, complexing with DMG, and distillation.

Learning Outcomes: Upon completing the course, students will be able to:

- Know basics of chromatography, various methods of chromatography along with separation of mixture of metal ions by paper chromatography.
- Apply various types of chromatographic techniques, including thin layer, column, ion exchange, gas chromatography, and HPLC for the identification, purification, and separation of chemical species.
- Comprehend the fundamental principles of gravimetric and volumetric analysis to determine the amount of known and unknown analytes in the samples.
- Separate various mixtures by paper chromatography, dimethylglyoxime-complexing , and distillation.

SECTION –A

Chromatography I

General introduction to chromatography, principles of chromatography, Classification, Mechanism of separation (Adsorption, Partition & Ion exchange), Development of Chromatogram: Frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: Paper chromatography (Various modes of development, nature of the paper, detection of spots, retardation factors, factors that affect the reproducibility of R_f values, selection of solvent, quantitative analysis, Separation of mixture of metal ions (Fe^{3+} and Al^{3+}) by Paper chromatography.

SECTION –B

Chromatography II

TLC (stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, R_f values, quantitative analysis, applications), Column Chromatography, Ion Exchange Chromatography. Determination of ion exchange capacity of anion/cation exchange resin, Gas chromatography (GC) and High-performance liquid chromatography (HPLC).

SECTION –C

Quantitative methods of analysis

Gravimetric analysis: Precipitation methods, Volatilization methods, Properties of precipitates and precipitating reagents, Drying and Ignition of precipitates,

***Volumetric analysis*.:** Definitions: Titrimetry, Volumetric titrimetry, Gravimetric titrimetry, Coulometric titrimetry, Theory of acid–base indicators, Action of Phenolphthalein, Action of Methyl Orange, selection of indicators and their limitations.

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A., Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed. 3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
3. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
4. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
5. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.

PRACTICAL COMPONENT OF SKILL ENHANCEMENT COURSE (SEC)

(SEMESTER II)

1. Separation of a mixture of two cations (Fe^{3+}, Al^{3+}, Co^{2+} and Ni^{2+}) by paper chromatography
2. Estimation of Cu^{2+} and Ni^{2+} by gravimetric method.
3. To separate a mixture of Ni^{2+} & Fe^{3+} by complexing with DMG and extracting the Ni^{2+} DMG complex in chloroform.
4. Separation of mixture of two organic liquids by distillation

(i) Ethanol and water

(ii) Propan-1-ol and propanone

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.