

Choice Based Credit System
S. Y. B. Sc.
Chemistry Syllabus
To be implemented from the Academic year 2017-2018

Course Content
Semester III

Course Code	Unit	Topics	Credits	L/Week
USCH301	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USCH302	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USCH303	I	Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis.		1
	III	Instrumental Methods-I		1
USCHP1		Chemistry Practicals I	1	3
USCHP2		Chemistry Practicals II	1	3
USCHP3		Chemistry Practicals III	1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USCH401	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Sulphonic acids		1
USCH402	I	Solid state, Catalysis	2	1
	II	Ions in aqueous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Amines, Diazonium salts, Heterocyclic compounds		1
USCH403	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USCHP4		Chemistry Practicals I	1	3
USCHP5		Chemistry Practicals II	1	3
USCHP6		Chemistry Practicals III	1	3

25. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
26. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
27. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt., Ltd. (2002).
28. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek Barton, W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Semester III

Paper III

Basics in analytical Chemistry

Theory: 45 Lectures

The Role of Analytical chemistry in various fields including non-chemistry fields such as Environmental Science, Pharmacy, Medicine, Life Sciences, Petrochemicals, Arts (like Painting) Forensic sciences and so on can never be underestimated. This course is expected to introduce the learner to this interesting field of Analytical Chemistry.

It is expected to provide the learner an overview of this very important branch of chemistry. After successful completion of this course the learner is expected to be familiar with the question of what is analysis, why it is required and the methods, techniques, procedures and protocols that may be used or required in the course of a given problem of analysis. The learner is also expected to appreciate the role of an Analytical Chemist and a Chemical Analyst.

Correctness or acceptability of the results of a given analysis and how to deal with wrong or erroneous results: when to reject them and when and how to retain them to be meaningful and/or acceptable are some other attributes expected as outcomes of learning this paper.

As such it is felt that this paper will be a subject of choice and interest for learners preferring a specialisation in Chemistry as well as to those who may have interests in other science fields as Physics, Botany, Zoology, Microbiology, Geochemistry and so on.

Goal:

To introduce the learner to an area of learning that is vital for the inherent nature of the subject itself but also is important and irreplaceable irrespective of the long term interest of specialisation or subject of interest of the learner.

**Unit I- Introduction to Analytical Chemistry and Statistical Treatment
of analytical data-I (15 L)**

Scope/ Objectives:

Learners should be able to

1. Select a method of analysis
2. Decide how to identify a sample and prepare it for analysis
3. Select a procedure for analysis
4. Identify sources of possible errors in the results obtained.

(Problems including numericals expected wherever necessary)

1.1. Role of Analytical Chemistry (9 L)

- 1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry.
- 1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)
- 1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance.

1.2. Significance of Sampling in Analytical Chemistry

- 1.2.1. Terms involved in Sampling
- 1.2.2. Types of Sampling
- 1.2.3. Sampling techniques

1.3. Results of Analysis. (6L)

- 1.3.1. Errors in Analysis and their types
- 1.3.2. Precision and Accuracy in Analysis
- 1.3.3. Corrections for Determinate Errors

(Problems including Numericals expected wherever required)

References:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, 7th Edition
3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch

4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

Unit II- Classical Methods of Analysis(15 L)

Objectives:

The main objectives of this unit is to

- Introduce classical methods of chemical analysis.
- Appreciate the various terms and types of titrimetric analysis.
- Ability to select proper titrimetric method
- Appreciate the usefulness of the gravimetric method of analysis
- Identify a suitable gravimetric method
- Perform the required calculations involved in the analysis by titrimetry as well as gravimetry.

2. Classical Methods of Analysis. (04L)

2.1. Titrimetric Methods

- 2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry
- 2.1.2. The Conditions suitable for titrimetry
- 2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations
- 2.1.4. Tools of Titrimetry: Graduated glasswares and Calibration

2.2. Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry.

2.3. Neutralisation Titrations (04L)

- 2.3.1. Concept of pH and its importance in Neutralisation Titrations
- 2.3.2. End point and Equivalence point of Neutralisation titrations
- 2.3.3. Determination of End point by using
 - i. Indicators causing colour change
 - ii. Change in potential, (by potentiometry)
 - iii. Change in conductance (by conductometry)
- 2.3.4. Construction of titration curve (on the basis of change in pH)of a titration of
 - i. Strong acid-weak base
 - ii. Strong base-weak acid

2.4. Gravimetric analysis (06 L)

- 2.4.1. General Introduction to Gravimetry.
- 2.4.2. Types of Gravimetric Methods –
- 2.4.3. Precipitation Gravimetry:
 - i. Steps involved in precipitation gravimetry analysis
 - ii. Conditions for precipitation
 - iii. Completion of precipitation,
 - iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.

- v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it to its oxide.

References:

- 1) Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15
- 2) Day and Underwood, "Quantitative analysis" prentice hall 1991, chapter 3
- 3) S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher
- 4) Gary D. Christan, "Analytical Chemistry", VIth Edition, Wiley Students Edition, Chapter No 8,9,10
- 5) Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
- 6) Modern Analytical Chemistry, David Harvey (page numbers 232 -265)

Unit III: Instrumental Methods-I [15 L]

Objectives:

On completing the learning of this unit the learner is expected to

- Know the various instrumental methods of analysis
- Advantages of using instruments to make measurements
- The various observable properties of a given analyte and the stimulus best suited for its analysis
- Know about a generalized diagram of an analytical instrument
- Select a suitable instrumental method for analysis
- Appreciate the basic terms in spectrometry
- Use the relationship between absorbance (and its variations) and concentration of the analyte.
- Chose a suitable method for photometric titrations.

3. Basic Concepts in Instrumental methods (03)

3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property.

3.2. Block Diagram of an Analytical instrument.

3.3. Types of Analytical Instrumental methods based on

- i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
- ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
- iii. Thermal interactions (eg. Thermogravimetry)

3.4. Spectrometry (07 L)

3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy

3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic

light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbivity

- 3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer-Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)
(Numerical problems based on Beer-Lambert's Law)
- 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers
- 3.4.5. Block Diagrams for Single beam and Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e , source ,Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube)
- 3.4.6. Applications of UV-Visible Spectrophotometry **(02 L)**
 - (a) Qualitative analysis such as Identification of functional groups in Organic compounds ,Chromophores and Auxochrome,*cis* and *trans* isomers
 - (b) Quantitative analysis by Calibration curve method and
- 3.4.7. Photometric Titrations: Principle ,Instrumentation, Types of Photometric titration Curves with examples. **(03L)**

References:

- 1.Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal ,
Sham K.Anand pp 2.107-2.148
- 2.Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle
7th Edition pp 118-181.

Semester III

Semester IV
Paper III Basics in Analytical Chemistry -II
Theory: 45 Lectures
Unit –I -Methods of separation (15 L)

Objectives:

The learner is expected to understand

- The importance of separation in sample treatment
- Various methods of separations
- How to select a method of separation of an analyte from the matrix
- How a solute gets distributed between two immiscible phases
- Principle of solvent extraction and various terms involved therein
- Effect of various parameters on solvent extraction of a solute
- Classification of Chromatographic methods
- Paper and thin layer chromatography and using them in practice.

1. Separation Techniques in Analytical Chemistry (02 L)

- 1.1.** An Introduction to Analytical Separations and its importance in analysis.
- 1.2.** Estimation of an analyte without effecting separation.
- 1.3.** Types of separation methods
 - 1.3.1.** Based on Solubilities (Precipitation, Filtration Crystallisation)
 - 1.3.2.** Based on Gravity- Centrifugation
 - 1.3.3.** Based on volatility-Distillation ;

- 1.3.4. Based on Electrical effects-Electrophoresis
- 1.3.5. Based on retention capacity of a Stationary Phase -Chromatography;
- 1.3.6. Based on distribution in two immiscible phases-Solvent Extraction;
- 1.3.7. Based on capacity to exchange with a resin-Ion Exchange;
- 1.4. Electrophoresis:** Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. (02L)
- 1.5. Solvent extraction (06 L)**
- 1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient.
- 1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.
- 1.5.3. Single step and multi step extraction, Percentage extraction for single step and multistep extraction. Separation factor.
- 1.5.4. Batch and continuous extraction
- 1.6. Chromatography : (05L)
- 1.6.1. Introduction to Chromatography
- 1.6.2. Classification of chromatographic methods based on stationary and mobile phase
- 1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.
- 1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction .

References :

1. D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch – Fundamentals of Analytical chemistry, 8th edition
2. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry
3. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987
4. Modern Analytical Chemistry , David Harvey (page numbers 596 -606)
5. Modern Analytical Chemistry , David Harvey (page numbers 215 -217)

Unit –II - Instrumental Methods-II (15 L)

Objectives

On completing this unit the learner is

- Expected to appreciate the nature of interaction between applied electrical potential and the concentration of the analyte.
- The nature of chemical reactions that influence potential of a given cell.
- Familiar with the various types of electrodes or half cells.
- Appreciate the nature, need and importance of pH
- Expected to know the applications of the various instrumental methods dealt with in this unit.

2. Instruments based on the electrochemical properties of the analytes

- 2.1. Potentiometry: (05 L)
- 2.1.1. Principle.
- 2.1.2. Role of Reference and indicator electrodes

- 2.1.3. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode)
- 2.1.4. Graphical methods for detection of end points
- 2.2. pHmetry: **(04 L)**
- 2.2.1. Principle
- 2.2.2. Types of pH meters.
- 2.2.3. Principle, Construction Working and Care of Combined Glass electrode
- 2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis.
- 2.3. Conductometry: **(06 L)**
- 2.3.1. Principle
- 2.3.2. Conductivity cell its construction and care
- 2.3.3. Applications in Neutralisation Titrimetry with respect to
- i. Strong Acid-Strong Base
 - ii. Strong Acid-Weak Base
 - iii. Strong Base-weak Acid
 - iv. Weak Acid- Weak Base.
- 2.3.4. Advantages & limitations of conductometric titrations.

References:

- 1) Principles of Instrumental analysis, D. A. Skoog, 3rd edition, Saunders college publishing. Chapters: 20, 23 Page nos: 600 - 605, 631, 704 - 711.
- 2) Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman. Chapters: XIV, XV Page nos: 566 - 601, 615 - 625.
- 3) Instrumental methods of analysis, B. K. Sharma, Goel publishing house. Miscellaneous methods: Chapters: 1, 3, 4 Page nos: 1 - 14, 21 - 57.

Unit III- Statistical Treatment of analytical data --II (15 L)

Objectives:

On completing this unit the learner is expected to understand

- i) The use of statistical methods in chemical analysis.
- ii) The nature of indeterminate errors
- iii) The randomness of such errors and its distribution around a correct or acceptable result
- iv) Computation of Confidence limits and confidence interval
- v) Test for rejection of doubtful result
- vi) Method to draw best fitting straight line

3.1.Nature of Indeterminate Errors: (03L)

- 3.1.1. The true and acceptable value of a result of analysis
- 3.1.2. Measures of central tendency: mean, median, mode, average
- 3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s,sigma) variance, coefficient of variation

3.2. Distribution of random errors: (02L)

3.2.1. Gaussian distribution curve.

3.2.2. Equation and salient features of Gaussian distribution curve

3.3. Concept of Confidence limits and confidence interval and its computation using (03 L)

(i) Population standard deviation

(ii) Student's t test

(iii) Range

3.4. Criteria for rejection of doubtful result (02 L)

(i) 2.5 d rule

(ii) 4.0 d rule

(iii) Q test

3.5. Test of Significance (02 L)

(i) Null hypothesis

(ii) F-test (variance ratio test)

3.6. Graphical representation of data and obtaining best fitting straight line (03 L)

(a) For line passing through origin

(b) For line not passing through origin

[Numerical problems wherever possible, expected]

References:

1. Modern Analytical Chemistry , David Harvey (page numbers 53 -84)
2. Fundamentals of analytical chemistry – Skoog and West

REFERENCES:

For paper III

- 1. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.**
- 2. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).**
- 3. R.V. Dils. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).**
- 4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi**