Academic Council Meeting No. and Date : 4 / June 14, 2022

Agenda Number : 2 Resolution Number : 4.4 & 4.12

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme : Bachelor of Science

Specific Programme : Chemistry

[S.Y.B.Sc. Chemistry]

Revised under Autonomy

From academic year 2022 - 2023

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Preamble

The syllabus spanning three years covers the industry relevant courses. The students will be ready for the jobs available in different fields of chemistry. The learner was introduced in the first two semesters of the six semester graduation program of B. Sc. (Chemistry) to some basic aspects of chemistry such as history of chemistry, physical concepts in the chemical systems, thermodynamics, chemical kinetics, molecular spectroscopy, solid state, periodictable, aliphatic and aromatic compounds, stereochemistry, analytical chemistry, Safety precautions in chemical laboratory, handling various glassware and instruments.

In continuation with it, two semesters of the second year of the B. Sc. (Chemistry) Program, the syllabus is designed to retain the interest of the learner of chemistry. In SEM III and Sem IV permutation combination of other branches of science learners keeping into consideration chemistry syllabus is designed. The syllabus includes laboratory sessions, theory papers having following objectives.

The major objectives of B.Sc. Chemistry course are

- To understand fundamental aspects of Chemistry.
- To aware of interdisciplinary significance of chemistry
- To impart knowledge about various instruments and to get hands on experience of handling chemicals, reagents, apparatus, instruments and safety aspects involved in suchhandling
- To make the learner capable of acquiring knowledge and skills to be employed in chemical industrial work.

Eligibility:

F. Y. B. Sc. Passed from this university (or with ATKT in any two courses at the F.Y.B Sc. Level) or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this university. F.Y.B.Sc with Chemistry as one of the subject combination.

Duration: 3 years

Mode of Conduct:

Laboratory practicals / Offline lectures / Online lectures

Program Outcome

- The learner is expected to be familiar with the chemical analysis, methods, techniques, procedures and protocols that may be used or required in the course of a given problem of analysis.
- Learners should be able to prepare and identify a sample, Select a method/procedure ofanalysis and identification of errors.
- Study of characterization of organic compounds skilful in handling various glassware and instruments.

Program Specific Outcome

- ➢ The students will comprehend the interdisciplinary nature of chemistry and integrate knowledge of other disciplines to a wide variety of chemical associated problems.

- The student will learn the laboratory skills/experimental techniques using instrumentation which may develop aptitude for scientific information
- Develop transferrable quantitative skills and able to work with others demonstrating leadership and collaborative skills.
- Students understand the fact of chemistry course for the environmental remediation

VPM's B.N.Bandodkar College of Science (Autonomous), Thane
S.Y.B.Sc. Chemistry Semester III and IV (Chemistry)
Structure of Programme

Semester III			
Course Code	**Course Title**	**No. of lectures**	**Credits**
BNBUSCH3T1	Paper-I (General Chemistry)	**60**	**2**
BNBUSCH3T2	Paper-II (General Chemistry)	**60**	**2**
BNBUSCH3T3	Paper-III Basics of Analytical	**60**	**2**
BNBUSCH3P1	Chemistry Practicals I	**30**	**1**
BNBUSCH3P2	Chemistry Practicals II	**30**	**1**
BNBUSCH3P3	Chemistry Practicals III	**30**	**1**
Total		**270**	**9**
Semester IV			
Course Code	**Course Title**	**No. of lectures**	**Credits**
BNBUSCH4T1	Paper-I (General Chemistry)	60	2
BNBUSCH4T2	Paper-II (General Chemistry)	60	2
BNBUSCH4T3	Paper-III Basics of Analytical	60	2
BNBUSCH4P1	Chemistry Practicals I	**30**	1
BNBUSCH4P2	Chemistry Practicals II	**30**	1
BNBUSCH4P3	Chemistry Practicals III	**30**	1
Total		**270**	**9**

Semester III

Course Code BNBUSCH3T1	Course Title Paper 1	Credits 2	Lectures 45

Objective

- To study various core areas of thermodynamics and electrochemistry.
- To make the learner capable of understanding the concept of chemical bonding.
- To make students aware of Reactions and reactivity of halogenated hydrocarbons:

Unit I:Physical Chemistry(15L)

1.1 Chemical Thermodynamics-II(8L)

1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature.

1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore. (Numericals expected).

1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.

1.1.4 Concept of Fugacity and Activity

1.2 Electrochemistry: (7L)

1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.

1.2.2 Kohlrausch law of independent migration of ions.

1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected).

1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.

Unit II:Inorganic Chemistry : ChemicalBonding(15L)

ChemicalBonding

2.1 Non-DirectionalBonding (4L)

2.1.1 IonicBond:ConditionsfortheFormationofIonicBond.

2.1.2 TypesofIonic Crystals

2.1.3 RadiusRatioRules

2.1.4 LatticeEnergy,Borne-Lande Equation

2.1.5 KapustinskiEquation

2.1.6 Born-HaberCycleandits Application

2.2 DirectionalBonding:Orbital Approach. (6L)

2.2.1 CovalentBondingTheValenceBondTheory-Introductionandbasic tenets.

2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system.

2.2.3 Corrections applied to the system of two hydrogen atoms- Formation of H_2

2.2.4 Homonuclear diatomic molecules from He_2 to Ne_2

2.2.5 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.

2.2.6 Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-sp, sp2, sp3, sp3d, sp2d2and sp2d sp3d2.

2.2.7 Equivalent and Non-Equivalent hybrid orbitals

2.2.8 Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp3 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3)

2.3 MolecularOrbitalTheory (5L)

2.3.1. Comparing Atomic Orbitals and Molecular Orbitals.

2.3.2. Linear combination of atomic orbitals. to give molecular orbitals LCAO- MO approach for diatomic homonuclear molecules).

2.3.3. Wave mechanical treatment for molecular orbitals (H_2^+ and H_2)

2.3.4 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-}(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry(15L)

3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]

3.1.1 Alkyl halides: Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions- nature of substrate, solvent, nucleophilic reagent and leavinggroup.

3.1.2 Aryl halides: Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzynemechanism

3.1.3.Organomagnesium and organolithium compounds: [3L]

Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides andepoxides

3.2 Alcohols, phenols and ethers:[8L]**andepoxides: [8L]**

3.2.1 Alcohols: Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions ofalcohols

3.2.2 Phenols: Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions ofphenols.

3.2.3 Epoxides: Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents,alkoxides.

3.2.4 ETHER

Introduction andNomenclature of ether, methods of preparation and reactions of Ether Cleavage of ethers with HI (Aliphatic and Aromatic ether)

REFERENCES:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
5. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
6. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.Chemistry of Transition Elements Pg.- 608 – 679 .
7. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
8. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
9. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
10. CNR Rao edited, University General Chemistry, 513-578.
11. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
12. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
13. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
14. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
15. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
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Unit III:

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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.

Course Code BNBUSCH3T2	Course Title Paper 2	Credits 2	Lectures 45

Objectives:

- To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.
- To make the learner proficient in analysing the various observations and chemical

phenomena presented to him during the course.

- To make the learner capable of solving problems in the various units of this course

Unit I:Physical Chemistry(15L)

1.1 Chemical Kinetics-II (7L)

1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), Thermal chain reactions: H. and Br. reaction. (Only steps involved, no kinetic expression expected).

1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected). **Effect of concentration of reactants**

1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories

(Qualitative treatment only)

1.2 Solutions: (8 L)

1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature -composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems

1.2.3 Immiscibility of liquids- Principle of steam distillation.

1.2.4 Nernst distribution law and its applications, solvent extraction.

1.2.5 Factors influencing solubility solids and gases-Temperature and Pressure

Unit II: Inorganic Chemistry Selected topics on p block elements (15L)

2.1 Chemistry of Boron compounds (5L)

2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.

2.1.2 Preparation of simple boranes like diborane and tetraborane.

2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)

2.1.4 Synthesis of Borax.

2.1.5 Uses of Boron compounds

2.2 Chemistry of Silicon and Germanium (5L):

2.2.1 Silicon compounds: Occurrence, Structure and inertness of SiO_2

2.2.2 Preparation of structure of $SiCl_4$

2.2.3 Occurrence and extraction of Germanium

2.2.4 Preparation of extra pure Silicon and Germanium

2.2.5 Importance of extra pure Silicon and Germanium in semiconductor industries

2.3 Chemistry of Nitrogen family (5L)

2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.

2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4.

2.3.3 Synthesis of ammonia by Bosch – Haber process.

2.3.4 Uses of ammonia

Unit III: Organic Chemistry : Carbonyl Compounds (15L)

3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds.Structure, reactivity of aldehydes and ketones and methods of preparation; oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, gattermann- koch formylation and Friedel Craft acylation of arenes.

3.2 General mechanism of nucleophilic addition, and acid catalysed Nucleophilic addition reactions.

3.3 Reactions of aldehydes and ketones with $NaHSO_3$,HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.

3.4 Mechanisms of following reactions: benzoin condensation, Knoevengel condensation, Claisen-schmidt and Cannizzaro reaction.

3.5 keto-enol tautomerism: Mechanism of
acid and base catalysed enolization.

3.5 Active methylene compounds:
Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols.
Reactions of Acetylacetone and ethyl acetoacetate(alkylation, conversion to ketone, mono- and dicarboxylic acid).

3.6 Reactions of aldehydes and ketones with alcohol

References:

Unit I:

1. Kenneth Connors. (1990). Chemical Kinetics. VCH Publishers.
2. Levine, Ira N. (1988). Physical Chemistry (Third edition). McGraw-Hill Inc.
3. Segel, Irwin. (1993). Enzyme Kinetics. Wiley Classics Library.
4. Garde,Shekhar, Garcia, Angel, Pratt, Lawrence, Hummer, Gerhard. " Temperature Dependence of the Non-polar Solubility of Gases in Water". Biophysical Chemistry. Volume 78. Issues 1-2. 1999.
5. Yalkowsky, Samuel H. Solubility and Solubilzation in Aqueous Media, 1st Edition.

Unit II:

1. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
2. Bruce H. Mahan, University Chemistry, Narosa publishing house
3. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India Pvt. Ltd.
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5. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
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10. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishing Company
11. Catherine E. Housecroft, Alan G. Sharpe, Inorganic Chemistry, Pearson Education Limited.

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1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
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10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Course Code BNBUSCH3T3	Course Title Paper 3	Credits 2	Lectures 45

- To introduce the learner to this interesting field of Analytical Chemistry.
- To aware the role of Analytical chemistry in fields chemistry and non-chemistry
- To introduce classical methods of chemicalanalysis and able to select proper instrumental methods and noninstrumental methods for their experiments.
- To perform the required calculations involved in the analysis by titrimetric as well as gravimetry.

UnitI- Introduction to Analytical Chemistry and Statistical Treatment analyticaldata-I (15L)

1.1. Role ofAnalyticalChemistry(9L)

1.1.1. Language of analytical chemistry: important terms and

1.1.1. Introduction and significance of analytical chemistry

1.1.2. Purpose of Chemical Analysis; Analysis Based-

(i) On the nature of informationrequired: (Proximate, Partial, Trace, Complete Analysis) and

(ii) On the size of the sample used (Macro, semi-micro and microanalysis)

1.1.3. Classical and Non-Classical Methods of Analysis; their types andimportance.

1.2. Significance of Sampling in AnalyticalChemistry

1.2.1. Terms involved inSampling

1.2.2. Types ofSampling

1.2.3. Samplingtechniques

1.3 ResultsofAnalysis. (6L)

1.3.1 Errors in Analysis and theirtypes

1.3.2 Precision and Accuracy inAnalysis

1.3.3 Corrections for DeterminateErrors

*(*Problems including Numerical expected wherever required)

UNIT II Classical Methods of Analysis 15L

2.1 Titrimetric Methods (04L)

2.1.1 Introductions, Types of titrimetry- Neutralisation (Acidimetric, alkalimetry), Redox,(Iodometry) Precipitation and Complexometric titrations and indicators used in these titrations

2.1.2 Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry

2.1.3 Tools of Titrimetry: Graduated glassware and Calibration

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

2.3 Neutralization Titrations(04L)

2.3.1 Concept of pH and its importance in Neutralization Titrations

2.3.2 End point and Equivalence point of Neutralization 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 Introduction, Types of Gravimetry

2.4.2 Precipitation Gravimetry

i. Steps involved in precipitation gravimetry analysis
ii. Conditions for precipitation
iii. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.
iv. 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

Unit 3. Basic Concepts in Instrumental methods (15L)

3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property. **(01**)

3.2. Block Diagram of an Analytical instrument. **(01**)

3.3. Types of Analytical Instrumental methods based on **(01**)

i. Optical interactions (eg.Spectrometry: UV-Visible, Polarimetry)

ii. Electrochemical interactions (eg. Potentiometric, 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 Absorbtivity

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**)

REFERENCE :

UNIT I

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 :

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,chapter3

3. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition NewAge InternationalPublisher
4. Gary D. Christan," Analytical Chemistry", VIth Edition, Wiley StudentsEdition, Chapter No8,9,10
5. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. JamesHoller, S. R. Crouch
6. Modern Analytical Chemistry, David Harvey (page numbers 232-265)

Unit III

1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K.Anand pp2.107-2.148
2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp118-181.
4. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K.Anand pp2.107-2.148
5. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp143-172.
6. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp118-181.

Course Code BNBUSCH3P1	Course Title Practical Paper 1	Credits 2	Lectures 45

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. To determine the critical solution temperature (CST) of phenol – Water System.
4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants.
6. To determine solubility of sparingly soluble salts (any two) conductometrically.
7. Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]
8. Crystallisation of potassium iodate and to estimate its purity before and after the separation.

Course Code BNBUSCH3P2	Course Title PracticalPaper 2	Credits 2	Lectures 45

ORGANIC CHEMISTRY Short organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β-Naphthyl benzoate
5. m-Dinitrobenzene from nitrobenzene
6. Phthalic anhydride from phthalic acidby sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

(**Any eight preparations)**

Course Code BNBUSCH3P3	Course Title Practical Paper 3	Credits 2	Lectures 45

BASICS IN ANALYTICAL CHEMISTRY

1.Tools of Analytical chemistry-I:

a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.
b) Weighing tools such as two pan balance and monopan balance, digital balances:
c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
d) Drying Devices: Hot Air Oven, Microwave Oven, Descicators, Vacuum descicators
e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

(The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal.

2.Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. (The learner is expected to know the role of the various reagents/chemicals used In the estimation, various steps involved. They should write the complete and Balanced chemical reaction for the formation of the Ni (DMG) 2 complex.

3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error.

(The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).

4. Determination of buffer capacity of acid buffer and basic buffer.

(The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)

5. Estimation of Aspirin

6. Gravimetric estimation of barium ions using K2CrO4 as precipitant calculation of % error.

(The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica

Crucible is required. They are also expected to state the error estimate of their results)

REFERENCES:

BNBUSCH3P1

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).

2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).

3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

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1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)

3. Furniss,B.S.;Hannaford,A.J.;Smith,P.W.G.;Tatchell,A.R.PracticalOrganic Chemistry,5th Ed., Pearson (2012)
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2. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
3. R.V. Dilts. “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.

Semester IV

Course Code BNBUSCH4T1	Course Title Paper 1	Credits 2	Lectures 45

Objective

- To infuse in the learner a spirit of inquiry into electrochemistry and phase equilibria
- To arouse the interest to pursue higher levels of learning in coordination compounds and their chemistry
- To impart knowledge of various reaction of carboxylic acids and their derivatives.

Unit I: Physical Chemistry **15L**

1.1Electrochemistry-II: (8 L)

1.1.1 Electrochemical conventions, Reversible and irreversible cells.

1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected).

1**.1.3** Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected)

1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected)

1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

1.1.6 pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected)

1.2 Phase Equilibria: (7L)

1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.

1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (Numericals expected)

1.2.3 Phase diagrams of one-component systems (water and sulphur).

1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system)

Unit II: Inorganic Chemistry(15 L)

2.1 ComparativeChemistryofthetransitionmetals(9 L)

2.1.1 Position in the periodic table; Natural occurrence principal ores and minerals;

2.1.2 Significance of special stability of d0, d5 and d10 leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)

2.1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer).

2.1.4 Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments.

2.1.5 Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis

2.1.6 Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper)

2.1.5 Variation of magnetic properties with temperature: Curie (Tc) and Neel (TN) temperature

2.2 CoordinationChemistry:(6L)

2.2.1 Introduction to Chemistry of Coordination Compounds

- **i.** Historical perspectives: Early ideas on coordination compounds
- **ii.** Basic terms and nomenclature.
- **iii.** Types of ligands
- **iv.** Isomerism :General Types with special reference to stereoisomerism of coordination compounds (C.N=6)
- **v.** Evidence for the formation of coordination compounds,

2.2.2.Theories of coordination compounds

- **i.** Werner's Theory of coordination compounds,
- **ii.** Effective atomic number rule.
- **iii.** Eighteen electron Rule

2.2.3.Nature of the Metal-Ligand Bond:

- **i.** Valence Bond Theory; Hybridisation of the central metal orbitals-sp3, sd3/d3s sp3d2/d2sp3, sp2d,
- **ii.** Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II), Fe(III), Co(II)/Co(III), Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN- and halides may be used)
- **iii.** Limitations of V.B.T

2.2.4. Application of coordination compounds.

UNIT III Organic Chemistry (15L)

3.1 Carboxylic Acids and their Derivatives : (10Lectures)

3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylicacids.

3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis ofnitriles.

3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction,Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relativereactivity.

3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acylsubstitution.

3.1.5. Mechanism of Claisen condensation and Dieckmanncondensation.

3.2 Sulphonic acids:[4L]

Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation.Reaction with alcohol, phosphorous pentachloride, IPSO substitution.

3.2 **Sulphonic acids:[2L]**

Physical and Chemical properties preparation of aromatic sulphonic acids by sulphonation of benzene toluene and naphthalene,

Comparative acidity of carboxylic acid and sulfonic acids.

Stereochemistry:[3L]

Stereochemistry of Cyclohexane , Bayer's Strain theory, heat of combustion of cyclohexenes , Conformation and Stability of cycloalkanes

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Unit I:

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2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New

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6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
6. Chemistry of Transition Elements Pg.- 608 – 679 .
7. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
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12. .Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
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15. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
16. Bruce H. Mahan, University Chemistry, Narosa publishing house.

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.
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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.

Course Code BNBUSCH4T2	Course Title Paper 2	Credits 2	Lectures 45

Objectives:

- To provide opportunity the learners- hands on experience of the various concepts and processes in the various branches of chemistry
- To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling
- To make the learner capable of analysing and interpreting results of the experiments he
- conducts or performs

Unit I: Physical Chemistry (15L)

1.1 Solid State: (7L)

1.1.1 Recapitulation of laws of crystallography and types of crystals. **Elements of symmetry**

1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected)

1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation

1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.

1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)

1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

1.2.5 Applications of catalysis

Unit II: Inorganic Chemistry:Ions in aqueous medium (15L)

Unit 2: (15L)

2.1 Acidity of Cations and Basicity of Anions €(8L)

i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius.

ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation

iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples

iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification on the basis of basicity

v. Importance of acidity and basicity of cations and anions in reaction mechanism

Uses and Environmental Chemistry of volatile Oxides and oxo-acids (7L)

i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid

ii. Uses and environments aspects of these acids

Unit III: Inorganic Chemistry:Nitrogen containing compounds and heterocyclic compounds (15L)

3.1.1 Amines: (4L)

Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines: Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction.

3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.

3.1 Diazonium Salts: **(3 L)**

Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene

3.3 Heterocyclic Compounds: **(5 L)**

3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5- numbered and 6-membered rings containing one heteroatom;

3.3.2. Synthesis of Furan, Pyrrole(Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),

3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.

3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction.Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.

3.3.5.Pyridine: Basicity. Comparison of Basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

3.4. **UV-Visible spectroscopy,**

3.4.1 Introduction **(3L)**

3.4.2 Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic effect.

3.4.3 Modes of transitions

3.4.4 Calculation of λ_{max} by Woodward and Fischer rules for dienes.

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw- Hill (2007).

2.Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).

3.Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).

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Course Code BNBUSCH4T3	Course Title Paper 3	Credits 2	Lectures 45
Unit I Separation Techniques in Analytical Chemistry (15 L)			

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 Based on-

1.3.1. Solubilities (Precipitation, Filtration Crystallisation)

1.3.2. Gravity- Centrifugation

1.3.3. Volatility-Distillation ;

1.3.4. Electrical effects-Electrophoresis

1.3.5. Retention capacity of a Stationary Phase -Chromatography;

1.3.6. 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.

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

2. Instruments based on the electrochemical properties of the analytes

2.1. Potentiometry: **(05 L)**

Principle , Types andRole of Reference and indicator electrodes

2.1.1. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode)

2.1.2. Graphical methods for detection of end points

2.2. pHmetry: **(04 L)**

2.2.1. Principle Types of pH meters.

2.2.2. Principle, Construction Working and Care of Combined Glass electrode

2.2.3 Applications in Titrimetry (Strtong 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.

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

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 :

Unit 1

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 2

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 3:

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

Course Code BNBUSCH4P1	Course Title Practical Paper 1	Credits 2	Lectures 45

1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically.
2. To determine the amount of HCl in the given sample potentiometrically.
3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate.
4. Industrial visit report
5. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.
6. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate.
7. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion hexanitrocobaltate (III) and its use to precipitate a large cation (potassium)
8. Inorganic salt – Calcium or magnesium oxalate using PFHS technique

Course Code BNBUSCH4P2	Course Title Practical Paper 2	Credits 2	Lectures 45

Organic Chemistry Qualitative Analysis of bi-functional organic compounds on the basis of

1. Prelimenary examination
2. Solubility profile
3. Detection of elements C, H, (O), N, S, X.
4. Detection of functional groups
5. Determination of physical constants (M.P/B.P)

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides. Students are expected to write balanced chemical reactions wherever necessary.
(Minimum 6 compounds to be analyzed)

Course Code BNBUSCH4P3	Course Title Practical Paper 3	Credits 2	Lectures 45

Paper III (Basics in analytical Chemistry)

1.Tools of Analytical Chemistry-II

- **a)** Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.
- **b)** Development chamber for chromatography
- **c)** Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)
- **d)** Conductivity cell (with respect to care and maintenance.)
- **e)** Combined Glass electrode (with respect to care and maintenance.)
- **f)** f.Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in (a) and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2.**Paper chromatography**: Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample.

3.Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions. (The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)

4.Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results).

5. Estimation of Fe (II) in the given solution by titrating against K2Cr2O7 **potentiometrically and calculation of % error.** (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results).

6.Gravimetric estimation of Sulfate as BaSO4 and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

(The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

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2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
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1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company(1972)

BNBUSCH4P3

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. Dilts. “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.

SCHEME OF EXAMINATIONS:

Theory Course	Semester End Assessment	60 Marks Each Theory Paper 40 Marks Internal for Each Theory Paper
Practical Course	Semester End Assessment	50 Marks Each Practical Paper

EVALUATIONSCHEME

Internals

Attendance	**Groupdiscussion/Active participation**	**Participations in Research projects/Conferences /seminar/workshop and competitions**	**Assignments**	**Leadershipqualities/ internship**	**Total**
05	**05**		**10**	**10**	**40**
OR ClassTest					
ORCertificationofSwayam Diksha/NPTELinconcerncourse					

TheoryExamination: **SuggestedFormatofQuestionpaper**

Duration:2Hours **TotalMarks:60**

- **Allquestionsarecompulsory**

Q. 1	Answer***anyTWO***ofthefollowing		**16**
	a	Basedon Unit I	
	b	Basedon Unit I`	
	c	Basedon UnitI	
	d	Basedon Unit I	
Q. 2	Answer***anyTWO***ofthefollowing		**16**
	a	Basedon Unit II	
	b	Basedon Unit II	
	c	Basedon Unit II	
	d	Basedon Unit II	
Q. 3	Answer***anyTWO***ofthefollowing		**16**
	a	Basedon Unit III	
	b	Basedon Unit III	
	c	Basedon Unit III	
	d	Basedon Unit III	
Q. 4			**12**
	a	Multiplechoicequestions	
	b	Onesentencequestion	
	c	TrueandFalse	

MarksDistributionandPassingCriterionforEachSemester

SEMESTER III

Theory					Practical		
CourseCode	Internal	Min marks for passing	Theory Examination	Min marksfor passing	CourseCode	Practical Examination	Min marks for passing
BNBUSCH3T1	**40**	**16**	**60**	24	BNBUSCH3P1	**150**	**60**
BNBUSCH3T2	**40**	**16**	**60**	24			
BNBUSCH3T3	**40**	**16**	**60**	24			

SEMESTER IV

Theory					Practical		
CourseCode	Internal	Min marks for passing	Theory Examination	Min marksfor passing	CourseCode	Practical Examination	Min marks for passing
BNBUSCH4T1	**40**	**16**	**60**	24	BNBUSCH4P1	**150**	**60**
BNBUSCH4T2	**40**	**16**	**60**	24			
BNBUSCH4T3	**40**	**16**	**60**	24			

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