S. S. Jain Subodh P. G. (Autonomous) College

*Affiliated to University of Rajasthan*

Re-Accredited with 'A' Grade with ( Highest Rating in Northern India ) CGPA - 3.72 by NAAC - UGC

# SCHEME OF EXAMINATION

# &

# DETAILED COURSE STRUCTURE

## FOR

## BACHELOR OF SCIENCE (B.Sc. Hons.)

## CHEMISTRY


**DEPARTMENT OF CHEMISTRY**

**S.S. JAIN SUBOD P.G. AUTONOMOUS COLLEGE**

**RAMBAGH CIRCLE, JAIPUR-302004**

**Bachelor of Science B.Sc. (Hons.)**
**Subject – Chemistry**

**Examination Scheme:**

| | Semester- I | | |
|---|---|---|---|
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-101** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-102** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-103** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-104** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-151** | **150 Marks** |
| | **Semester- II** | | |
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-201** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-202** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-203** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-204** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-251** | **150 Marks** |
| | **Semester- III** | | |
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-301** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-302** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-303** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-304** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-351** | **150 Marks** |
| | **Semester- IV** | | |
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-401** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-402** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-403** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-404** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-451** | **150 Marks** |
| | **Semester- V** | | |
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-501** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-502** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-503** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-504** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-551** | **150 Marks** |
| | **Semester- VI** | | |
| **Paper** | **Nomenclature of Paper** | **Paper Code** | **Max. Marks** |
| **Paper-I** | **Inorganic Chemistry** | **BCHE(H)-601** | **75 Marks** |
| **Paper-II** | **Organic Chemistry** | **BCHE(H)-602** | **75 Marks** |
| **Paper-III** | **Physical Chemistry** | **BCHE(H)-603** | **75 Marks** |
| **Paper-IV** | **Analytical Chemistry** | **BCHE(H)-604** | **75 Marks** |
| **Chemistry Practical** | | **BCHE(H)-651** | **150 Marks** |

**Examination Scheme for each Paper**

**Part A** **10 QUESTIONS (very short ans ques. with any 7 out of 10)** **7X 2 MARK EACH = 14 Marks**
**Part B** **4 QUESTIONS (1 question from each unit with Internal choice)** **4 X 10 MARK EACH = 40 Marks**
**Total of End semester exam (duration of exam 3 hours)** **= 54 Marks**
**Internal assessment** **= 21 Marks**
**Maximum Marks (Each theory paper)** **= 75Marks**
**Max. Practical Marks** **= 150 Marks**
**(Internal Marks 60+ external marks 90)**

**Total of Theory Papers: 4 X 75Marks Each = 300 Marks (Min. Pass Marks 40%)**

**Total of Practical Marks = 150Marks**

**Grand Total of Subject per Semester = 450 Marks**

# BACHELOR OF SCIENCE

## Subject:
## Chemistry
## Semester I

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)101 | Inorganic Chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)102 | Organic Chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)103 | Physical Chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)104 | Analytical Chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)151 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given

below.ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
|---|---|---|---|---|
| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours**

**durationEach Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for thepaper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subjectseparately.

**Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21marks forinternal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester I

**Max. hrs: 3 hrs.** **Max. Marks: 75**

**Part A**- comprises of ten very short answer questions from all units. Attempt any seven. (It's a compulsory question) 2x7= 14marks

**Part B**- comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21 marks

**Total 75 marks**

**Paper I Inorganic Chemistry BCHE (H) 101** **45 Hrs (3hrs/Week)**

## Unit I

**Ionic bond**

General characteristics, types of ions, size effects, radius ratio and coordination number, Madelung constant, Born Haber cycle, application of lattice energy, polarizing power and polarisability, Fajan's rule, hydration energy, solubility of ionic compounds, defects in structures, Frenkel and Schottky defects, non- stiochiometric compounds. Metallic Bond: Qualitative idea of free electron, valence bond and band theories, semiconductors and insulators, conduction in ionic solids, electrical and magnetic properties of solids, introduction to superconductors and super-conductivity.

## Unit II

**Covalent bond**

General characteristics, Valence bond theory and its limitations, directional characteristics of covalent bond, resonance and resonance energy, hybridization involving s, p and d- orbitals, valence shell electron pair repulsion (VSEPR) theory for $H_3O^+$, $NH_3$, $H_2O$, $SF_4$, $ClF_3$, $ICl_3$, Shapes of simple inorganic molecules and ions, dipole moment, percentage ionic character from dipole moment and electronegativity difference.

## Unit III

**Molecular Orbital Theory**

Detailed description of linear combination of atomic orbital (LCAO), homonuclear molecules ($H_2$, $He_2$, $B_2$,$C_2$, $N_2$, $O_2$,$F_2$) and heteronuclear diatomic molecules (CO, NO) and their ions, comparison of valence bond theory and molecular orbital theories, multicentre bonding in electron deficient molecules, bond strength and bond energy.

## Unit IV

**Weak interactions**

Hydrogen bond, theories of hydrogen bonding: valence bond treatment, weak intermolecular forces of attraction, Van der Waals forces.

**Chemistry of noble gases**

Position in the periodic table, discovery, isolation, important compounds of noble gases with special reference to xenon compounds: synthesis, bonding and their stereochemistry

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester I

**Paper II Organic Chemistry BCHE (H) 102** **45 Hrs. (3hrs/Week)**

## Unit I

**Mechanism of organic reaction**

Free radical and ionic reactions, homolytic and heterolytic bond breaking, electrophiles and nucleophiles. Types of organic reactions, energy considerations, transition states, reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes with examples. Assigning formal charges on intermediates and other ionic species. Method of determination of reaction mechanism

## Unit II

**Alkanes**

Nomenclature of branched and unbranched alkanes, classification of carbon atoms in alkanes, isomerism in alkanes sources, methods of formation (with special reference of Wurtz reaction, Kolbe reaction, Corey House reaction and decarboxylation of carboxylic acids.) physical properties and chemical reactions of alkanes, mechanism of free radical halogenations of alkanes, orientation, reactivity and selectivity.

**Cycloalkanes**

Nomenclature, method of formation, chemical reactions, Baeyer strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring: banana bond.

## Unit III

**Alkenes**

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydrations. The Saytzeff rule, Hofmann elimination. Physical properties and relative stabilities of alkenes. Chemical reactions of alkenes—mechanism involved in hydrogenations, Markownikoffs rule, hydroboration –oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Subsititution at the allylic and vinylic position of alkenes. Industrial applications of ethylene and propene.

**Cycloalkenes :** Method of formation, conformation and chemical reactions of cycloalkenes.

## Unit IV

**Dienes**

Nomenclature and classification , isolated, conjugated and cumulated dienes, structure of allenes and butadiene, methods of formation, polymerization, chemical reactions, 1,2 and 1,4- additions, Diels-Alder reaction.

**Alkynes**

Nomenclature, structure and bonding in alkynes, methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, Hydroboration-oxidation, metal – ammonia reduction, oxidation and polymerisation.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester I

**Paper III Physical Chemistry BCHE (H) 103** **45 Hrs (3hrs/Week)**

## Unit I

### Gaseous States

### Ideal Gases

Concept of molar mass and molar volume. Determination of molar mass of a gas and volatile substance. The barometric distribution law. Maxwell distribution law of molecular velocities. The Maxwell Energy Distribution. The Maxwell Boltzmann distribution law and its experimental verification.

### Real Gases

Causes of deviations from ideal gas behavior. Van der Waal's equation and its implications. Isotherms of Vander Waal's gas. Critical phenomenon and critical constants. Reduced equation of state and the law of corresponding states.

## Unit – II

### Liquid State

Thermal expansion and compressibility, heat of vaporization. Determination of vapour pressure and heat of vaporization. Disorder in liquid state and structure of liquid water. Intermolecular forces. Cohesion of liquids. Eyring theory of liquids, liquid crystals: difference between liquid crystal, solid and liquid. Classification, structure and application of liquid crystal.

## Unit – III

### Solid State

Crystalline and amorphous states. Isotropy and anisotropy, elements of symmetry. Law of rational indices. Weiss and Miller indices and equation of plane in intercept form. Law of constancy of angles. Unit cell and space lattice. Powder method of X-ray examination of crystals.

## Unit – IV

### Chemical Kinetics

Rate, Initial rate, specific rate, rate constant and units. Method of determination of initial rate. Order, molecularity and stoichiometry of the reaction. Methods of determination of order of a reaction. Derivation of integrated rate equations-zero order, first order, second order and third order. Graphical applications of these equations for the determination of rate constant. Effect of temperature on the rate constant. Arrhenius equation, energy of activation and its determination. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester I

**Paper IV Analytical chemistry BCHE (H) 104** **45 Hrs**
**(3hrs/Week)**

## UNIT I

**Basic concepts in Analytical Chemistry**

Cleaning and calibration of glassware, significant figures, error in analysis, accuracy and precision, compilation and reliability of results, mean, mode, median, standard deviation, T, Q and F test, correction in analysis.

## UNIT II

**Volumetric Analysis**

Basic Principles of volumetric Analysis. Simple theoretical background of following types of titrations:
Iodometric & iodimetric titrations**:** Basic principle, application in standardization of iodine by $CuSO_4$-hypo and $H_3 AsO_3$.
Redox titrations **:** Standard potential, SHE, electrochemical series, emf calculations, internal & external indicators, applications in $K_2Cr_2O_7$ oxidation reaction.
Complexometric titrations**:** Types of EDTA titrations, masking and de-masking agents, metal ion indicator, application in estimation of total hardness.
Precipitation titrations**:** Basic principle, application in Volhard's method

## UNIT-III

**Gravimetric Analysis**

Principles of gravimetric analysis, precipitation methods, super saturation & precipitation formation and purity of precipitate, coprecipitation , post precipitation, conditions for precipitation, precipitation from homogenous solution, washing and ignition of the ppt, masking and demasking agent.

## Unit IV

**Solvent Extraction**

Principles and Process of solvent extraction, distribution law & partition coefficient, liquid- liquid extraction, factors favoring solvent extraction, choice of solvent for solvent extraction, stripping, solid liquid extraction, organic reagents used in solvent extraction.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester I

**Chemistry Practical** **BCHE (H) 151** **60 hrs (4 hr/week)**

**Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

| | | |
|---|---|---|
| Duration 7 hours | | Max. Marks: 90 |
| Experiment no. 1 | Inorganic Chemistry | 18marks |
| Experiment no. 2 | Organic Chemistry | 25marks |
| Experiment no. 3 | Physical Chemistry | 25marks |
| | Record | 11 marks |
| | Viva | 11marks |

## Inorganic Chemistry

Qualitative: To analyse the given mixture containing six radicals (three acidic radicals and six basic radicals including combination test)

## Organic Chemistry

Determination of mixed melting point, melting point and crystallization

Identification of functional groups in organic compounds: unsaturation, alcoholic (-OH), phenolic (-OH), aldehydic, ketonic, carboxylic, ester, carbohydrate, nitro, amido, amino, sulphonic acids and halogen derivatives.

## Physical Chemistry

1. Determine the relative viscosity of a liquid by using viscometer
2. Determine the relative surface tension of a liquid by using stalagmometer
3. Determine the heat of neutralization of an acid by alkali
4. To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method.
5. To determine the percentage composition of a given binary mixture by surface tension method.

**Viva-Voce and Record**

# BACHELOR OF SCIENCE

## Subject: Chemistry

## Semester II

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)201 | Inorganic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)202 | Organic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)203 | Physical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)204 | Analytical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)251 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given below.

ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
|---|---|---|---|---|
| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration**

**Each Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

**Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21marks for internal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester II

**Max.hrs: 3 hrs.** **Max. marks : 75**

**Part A**- comprises of ten very short answer questions from all units. Attempt any seven. (It's a compulsory question) 2x7= 14marks

**Part B**- comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21 marks

**Total 75 marks**

**Paper I Inorganic Chemistry BCHE (H) 201** **45 Hrs (3hrs/Week)**

## Unit I

**s-Block Elements**

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems and introduction to alkyls and aryls.

## Unit II

**Periodicity of p- block elements**

Comparative study of p-block elements and group trends, electronic configuration, physical and chemical properties, atomic and ionic radii, ionization potentials, electron affinity, electronegativity andoxidation states, catenation, inert pair effect.

## Unit III

**Compounds of p- block elements**

Hydrides of boron, diborane and higher boranes, borazines, borohydrides, fullerenes, carbides, flurocarbons, silicates (structural principle), silicones, oxygen fluorides, peracids of sulphur, tetrasulphur tetranitride, basic properties of halogens, interhalogen compounds and polyhalides.

## Unit IV

**d-block elements**

**Chemistry of elements of first transition series**

Electronic configuration and comparative study with respect to atomic and ionic radii, oxidation states, ionization potential, redox potential, oxidation state diagrams on the basis of redox potentials, binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry, metallic nature , magnetic properties, catalytic activity, colour and spectral properties of transition metal ions.

**Chemistry of second and third transition series**

Electronic configuration, general characteristics, comparative treatment with their 3-d analogues in respect to atomic and ionic radii, oxidation states, magnetic behaiour, spectral properties and stereochemistry.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester II

**Paper II Organic Chemistry BCHE (H) 202** **45 Hrs (3hrs/Week)**

## Unit I

**Stereochemistry of organic compounds**

Concept of isomerism, type of isomerism. Optical isomerism; elements of symmetry, molecular chirality, enantiomers, chiral and achiral molecules with two stereogenic centres, distereomers Threo, and erythro diastereomers, meso compounds. Resolution of enantiomers , inversion, retention and racemisation, relative and absolute configuration, sequence rule, D&L and R&S system of nomenclature.

**Geometrical isomerism**

Determination of configuration of geometrical isomers, E&Z- system of nomenclature, geometric isomerism in oximes and in alicyclic compounds.

**Conformational isomerism**

Conformational analysis of ethane and n-butane. Newman projection and Sawhorse formulae. Fischer and flying wedge formula. Difference between configuration and conformation.

## Unit II

**Arenes and Aromaticity**

Nomenclature of benzene derivatives. The aryl group, aromatic nucleus and side chain. Structure of benzene, molecular formula and Kekule structure. Stability and carbon-carbon bond length of benzene, resonance structure, MO picture.

**Aromaticity**

The Huckel's rule and its application

## Unit III

**Aromatic Electrophilic Substitution**

General pattern of the mechanism, role of sigma and pi complexes. Mechanism of nitration, halogenations, sulphonation, mercuration and Friedel Craft reaction , effect of substituent groups (inductive, mesomeric/resonance and hyperconjugative effect). Activating and deactivating groups, determination of orientation upto disubstituted derivatives, ortho/para ratio. Birch reduction. Method of formation of chemical reaction of benzene , alkyl benzenes and biphenyl.

## Unit IV

**Alkyl and Aryl Halides**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanism of nucleophilic substitution , reaction of alkyl halides, $SN^1$ and $SN^2$ reaction with energy profile diagram. Methods of formation of aryl halides, nuclear and side chain reaction. The addition-elimination and the elimination addition mechanism of nucleofilic aromatic substitution reaction. Relative reactivities of alkyl halides v/s allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester II

**Paper III Physical Chemistry BCHE (H) 203** **45 Hrs (3hrs/Week)**

## Unit – I

### Thermodynamics

Definition of thermodynamic terms. Concept of work and heat. Work of expansion and compression. Zeroeth law of thermodynamics. First law of thermodynamics, exact and inexact differentials. First law of thermodynamics under isothermal and adiabatic conditions respectively. Enthalpy and changes at constant temperature and pressure. Concept of $C_p$ and $C_v$ and their thermodynamic relationship.

## Unit – II

### Thermochemistry

Standard state, standard enthalpy of formation-Hess's law of heat summations and its applications, heat of reaction at constant pressure and constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy. Kirchoff's equation.

## Unit – III

### Solutions

Solutions of gases in liquids, Henry's law and its application to respiration. Solutins of solids in liquids and distribution law. Distribution law and extraction processes.

Osmosis, Osmotic Pressure, Determination of osmotic pressure. Lowering of vapour pressure. Relative lowering of vapour and Roult's law. Depression in freezing point and elevation in boiling point. Vant Hoff's factor and its implications.

## Unit – IV

### Colloidal State

Definition of colloids, Classification of colloids. Solids in liquids (sols): Properties-kinetic, optical and electrical. Stability of colloids, protective action, Hardy Schulz law, Gold number. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids. Liquid in liquid (emulsions): types of emulsions, preparation. Emulsifiers.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester II

**Paper IV Analytical chemistry BCHE (H) 204** **45 Hrs (3hrs/Week)**

## Unit I

Distillation methods of organic solvents, steam, fractional, vacuum and molecular distillations, monometers and monostates, analysis of oils and fats, saponification value, iodine value, RM value, acid value.

Quantitative estimation of following functional groups- alcoholic, phenolic, carboxylic acids and unsaturated groups (olefinic & acetylenic).

## Unit II

**Polarimetry**
Basic principle, instrumentation, experimental techniques, determination of (a) specific rotation of a substance(b) concentration of substance & applications. An elementary idea of refractrometry, interferometry- circular dichroism & optical rotatory dispersion.

## Unit III

**Water pollutants and their analysis**
Water analysis pollutants, analysis of water for dissolved oxygen, BOD and COD, biological treatment methods, prevention of water pollution by treatment of industrial wastes with special reference to cement industry, fertilizer industries and dyeing industries.

## Unit IV

**Air Pollution**
General consideration types of air pollutants, unit of measurement sampling monitoring and analysis of CO and $SO_2$ in atmosphere effect of air pollutants on plants and human health method for pollution control, specially for pollution by automobiles.

# BACHELOR OF SCIENCE
## Subject: Chemistry
## Semester II

**Chemistry Practical** **BCHE(H) 251** **60 hrs (4 hr/week)**

**Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

| | | | |
|---|---|---|---|
| Duration 7 hours | | | Max. Marks: 90 |
| Experiment no. 1 | Inorganic Chemistry | 18marks | |
| Experiment no. 2 | Organic chemistry | 25marks | |
| Experiment no. 3 | Physical Chemistry | 25marks | |
| | Record | 11 marks | |
| | Viva | 11marks | |

### Inorganic Chemistry

Qualitative: To analyze the given mixture containing six radicals (three acidic radicals and three basicradicals including fluoride, borate, oxalate and phosphate) and excluding insoluble.

### Organic Chemistry

Identification of simple organic compounds by functional group determination and preparation of suitable derivatives.

### Physical Chemistry

1. To study the solubility curve of phenol in water and hence study the effect of separate addition of substances such as naphthalene, potassium chloride and acetic acid.
2. Determination of pH of different buffer solutions and evaluate the pk of an acid by Handerson equation.
3. Determine the molecular complexity of benzoic acid in benzene by distribution law
4. Determine the heat of reaction and verify Hess's law.

### Viva-Voce and Record

# BACHELOR OF SCIENCE

## Subject: Chemistry
## Semester III

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)301 | Inorganic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)302 | Organic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)303 | Physical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)304 | Analytical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)351 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given below.

ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
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| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration**

**Each Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

**Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21marks for internal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester III

**Max.hrs: 3 hrs.** **Max. marks : 75**

**Part A**- comprises of ten very short answer questions from all units. Attempt any seven. (It's a compulsory question) 2 x 7= 14marks

**Part B**- comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21 marks

**Total 75 marks**

## Paper I Inorganic Chemistry BCHE (H) 301 45 Hrs (3hrs/Week)

### Unit I

**Acids and Bases**

Theories: Arrhenius (Water- ion system), Bronsted- Lowry (The proton donor acceptor system), The Lux-Flood (oxide ion concept), solvent system and solvolysis and Lewis concepts of acids and bases (The electron donor acceptor concept). Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid- base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

### Unit II

**Non-aqueous solvents**

Physical properties of solvent, types of solvent and their general characteristics, reactions in non-aqueous solvents with reference to liq. $NH_3$, liq. $SO_2$ and liq.HF.

### Unit III

**Oxidation and Reduction**

redox potential data and their analysis, redox stability in water, disproportionation, frost, latimer and pourbaix diagrams, application of redox data in the extraction of the elements.

### Unit IV

**Chemistry of Lanthanide Elements**

General study, occurrence and isolation, electronic configuration, oxidation states and ionic radii, lanthanide contraction and its consequenses, magnetic properties, complex formation of lanthanide compounds.

**Chemistry of Actinides**

General study, chemistry of separation of Np, Pu and Am from U, electronic configuration, oxidation states, magnetic properties, complexation behavior, comparison of lanthanide and actinide. Superheavy elements.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester III

**Paper II Organic Chemistry BCHE (H) 302** **45 Hrs (3hrs/Week)**

## Unit I

**Alcohols**

Classification and nomenclature. Monohydric alcohols : primary, secondary and tertiary alcohols, Methods of preparation. Hydrogen bonding, acidic nature, reaction of alcohols.

Dihydric alcohols- nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidation cleavage [$Pb(OAc)_4$ and $HIO_4$] and pinacol- pinacolone rearrangement.

Trihydric alcohols- nomenclature , methods of formation, chemical reactions of glycerol.

## Unit II

**Phenol**

Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character. Comparative acidic strength of alcohols and phenols, resonance stabilization of phenoxide ion, reaction of phenols. Mechanisms of Fries rearrangement, Claisen rearrangement. Gattermann synthesis, Hauben-Hoesch reaction, Lederer Manasse reaction and Reimer Tiemann reaction.

## Unit III

**Aldehyde and ketones**

Nomenclature and structure of the carbonyl group. Synthesis of aldehyde and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehyde and ketones using 1, 3 dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, reactivity, Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, perkin and Knovenagel condensations, condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction, use of acetals as protecting group, oxidation of aldehyde and ketones, Cannizzaro reaction, Bayer Villiger oxidation of ketones, MPV, Clemmensen's reduction, Wolf Kishner reduction, $LiAlH_4$ and $NaBH_4$ reduction, Halogenation of enolizable ketones.

## Unit IV

**Organic synthesis via Enolates**

Acidity of α hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethylacetoacetate; The Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3- dithianes, alkylation and acylation of enamines.

**Ethers and epoxides**

Nomenclature of ethers and methods of their formation, physical properties, chemical reactions- cleavage and auto oxidation, Ziesel 's method. Synthesis of epoxides. Acid and base- catalyzed ring opening of *epoxides*, orientation of epoxide ring opening; reactions of Grignard and organolithium reagents with epoxides.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester III

**Paper III Physical Chemistry BCHE (H) 303** **45 Hrs (3hrs/Week)**

## Unit –I

**Electrochemistry-I**

Electrolytic conduction, specific, equivalent and molar conductivities and their determination. Variation of conductance with dilution. Kohlrausch's law and its applications. Inter-ionic attraction theory, quantitative treatment of theory of strong electrolytes, verification of the Debye-Huckel Onsager equation, Transference number and its determination by Hittorf's method and moving boundary method. Abnormal transference numbers. Applications of conductance measurements, degree of dissociation of weak electrolytes, ionic product of water, solubility and solubility product of sparingly soluble salts, hydrolysis constant of salts, conductometric titrations.

## Unit -II

**Ionic Equilibrium**

Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and triprotic acids (exact treatment), salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, Buffer solutions derivation of Henderson equation and its applications, buffer capacity, buffer range, buffer action. Solubility and solubility product of sparingly soluble salts, applications of solubility product principle.

## Unit – III

**Chemical equilibrium**

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le- Chatelier`s principle. Reaction isotherm and reaction isochore – Clapeyron equation and Clausious- Clapeyronequation, application.

## Unit – IV

**Thermodynamics -II**

Limitations of first law of thermodynamics. Spontaneous processes. Second law of thermodynamics. Carnot cycle, Kelvin scale of temperature, concept of entropy. Entropy changes for an ideal gas. Entropy changes for physical transformation. Entropy of mixing, physical significance of entropy. Free energy and work function. Criteria of chemical equilibrium. Gibb's Helmholtz equation. Third law of thermodynamics and determination of absolute entropies. Effect of temperature on free energy and enthalpy. Maxwell's thermodynamic relations.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester III

**Paper IV Analytical chemistry BCHE (H) 304** **45 Hrs (3hrs/Week)**

## Unit I

**Chromatography**
Principles of absorption and partition chromatography, techniques and application of column, paper and thin layer chromatography, electrophoresis and its applications in separation of amino acids.

## Unit II

**Ion Exchange Methods**
General discussion , action of ion exchange resins, column operation , experimental techniques, types of ion exchange resins, determination of the following pairs by ion exchange techniques: (a) chloride and bromide (b) nickel and cobalt.

## Unit III

**Conductometric titrations**
The basis of conductometric titrations, apparatus and measurement, application of conductometric titrations , high frequency titration, advantages of the techniques, some examples of high frequency titrations.

## Unit IV

**Potentiometric titrations**
Introduction , electrodes, instrumentation, potentiometric titrations, differential Potentiometric titrations, automatic potentiometric titrations, location of end points, determination of some metals through potentiometric titrations.

# BACHELOR OF SCIENCE
# Subject: Chemistry
# Semester III

**Chemistry Practical** **BCHE (H) 351** **60 hrs (4 hr/week)**

**Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

| | | |
|---|---|---|
| Duration 7 hours | | Max. Marks: 90 |
| Experiment no. 1 | Inorganic Chemistry | 25marks |
| Experiment no. 2 | Organic chemistry | 20marks |
| Experiment no. 3 | Physical Chemistry | 25marks |
| | Record | 10 marks |
| | Viva | 10marks |

## Inorganic Chemistry

### Quantitative (Gravimetric) any three

(a) Estimation of barium (as sulphate)
(b) Lead (as chromate)
(c) Copper (as cuprous thiocyanate)
(d) Nickel (as dimethyl glyoximate)
(e) Silver (as chloride)
(f) Zinc (as zinc ammonium phosphate)
(g) Magnesium (as magnesium hydrogen phosphate)

### Volumetric (any one)

**1.** Determination of total hardness of water.
**2.** Iodometric titrations
**3.** Complexometric titrations.

## Organic Chemistry

### Quantitative analysis

a) Determination of neutralization equivalent of an acid
b) Determination of the saponification value of an ester/oil
c) Estimation of glucose by titration with Fehling solution/Benedict solution

## Analytical Chemistry

### Using TLC/ Column /Paper chromatography techniques:

a) Determination of $R_f$ value and identification of organic compounds.

b) To separate spinach extract in to some of its individual components.

c) To separate the given mixture of amino acids.

# BACHELOR OF SCIENCE

## Subject: Chemistry

## Semester IV

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)401 | Inorganic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)402 | Organic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)403 | Physical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)404 | Analytical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)451 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given below.

ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
|---|---|---|---|---|
| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration**

**Each Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

**Note: Maximum marks for a theory paper is 75 marks which include 54marks for ESE and 21marks for internal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester IV

**Max.hrs: 3 hrs.** **Max. Marks: 75**

**Part A**- comprises of ten very short answer questions from all units. Attempt any seven.
(It's a compulsory question) 7x2= 14marks

**Part B**- comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21marks

**Total 75 marks**

**Paper I Inorganic Chemistry BCHE (H) 401** **45 Hrs (3hrs/Week)**

## Unit I

### Coordination Compounds

Werner's coordination theory, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds. Magnetic properties of transition metal complexes.Types of magnetic behaviour, determination of magnetic susceptibility, orbital contribution of magnetic moments , spin-only formula, L-S coupling, correlation of $\mu_s$ and $\mu_{eff}$ values, applications of magnetic moment data for 3d metal complexes.

## Unit-II

### Theories of Coordination compounds

Valence bond theory of transition metal complexes , limitations of valence bond theory, crystal-field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal – field parameters, jahn teller effect, application of crystal-field stabilization energy in explaining ionic radii of first transition series, heat of hydration of divalent ions of first transition series.

## Unit III

### Electronic spectra of transition metal complexes

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, orgel-energy level diagram for $d^1$ and $d^9$ states, discussion of the electronic spectrum of $[Ti(H2O)_6]^{+3}$ complex ion.

## Unit IV

### Thermodynamic and kinetic aspects of metal complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester IV

**Paper II Organic Chemistry BCHE (H) 402** **45 Hrs (3hrs/Week)**

## Unit I

**Electromagnetic spectrum: Absorption spectra (UV)**

Ultraviolet absorption spectroscopy- absorption laws (Beer- Lambert Law) molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of solvents on transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic and hyperchromic and hypochromic shifts, UV spectra of conjugated enes and enones.

**Infrared IR absorption spectroscopy**

Molecular vibrations, Hookes law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

## Unit II

**Carboxylic acids**

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength, comparison of acidity with phenols, preparation of carboxylic acids, reactions of carboxylic acids – Hell Volhard Zelinisky reaction, synthesis of acid chlorides, esters and amides, reduction mechanism of decarboxylation.

Aromatic carboxylic acids: synthesis and reaction of benzoic acid, salicylic acid.

Method of formation and chemical reaction of α, β- and γ-hydroxy acids, malic, tartaric and citric acids.

Methods of formation and chemical reactions of α, β- unsaturated monocarboxylic acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

## Unit III

**Carboxylic acids derivatives**

**S**tructure and nomenclature of acid chlorides**,** esters, amides (urea) and acid anhydrides, relative stability of acyl derivatives. Physical properties, inter conversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions, mechanism of esterification and hydrolysis ( acidic and basic ).

**Fats, oils and detergents**

Natural fats edible and industrial oils of vegetable origin common fatty acids, glycerides, hydrogenation of unsaturated oils. saponification value, iodine value, acid value, soaps, synthetic detergents, alkyl and aryl sulphonates.

## Unit IV

**Organic compounds of nitrogen**

Preparation and chemical reaction of nitroalkanes. mechanism of nucleophilic substitution in nitro arenes and their reduction in acidic, neutral and alkaline medium, picric acid. structure and nomenclature of amines, physical properties, stereochemistry of amines. Separation of mixture of primary, secondary and tertiary amines, structural features effecting basicity of amines. Amines salts as phase transfer catalyst, preparation of alkyls and aryl amines ( reduction of nitro compounds, nitriles). Gabriel- Pthalimide reaction, Hofmann bromamide reaction, reaction of amines.

**Aryl diazonium salts**

Preparation and synthetic transformations, azo coupling, diazomethane and its applications.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester IV

**Paper III Physical Chemistry BCHE (H) 403** **45 Hrs (3hrs/Week)**

## Unit – I

### Quantum Chemistry

Quantum theory of radiations, photoelectric effect and Compton effect. Limitations of Bohr's model. Heisenberg's uncertainty principle, wave nature of electron, De Broglie wave equation and its experimental verification. Operators and their applications. Sinusoidal wave motion, derivation of Schrodinger's wave equation. Physical significance of (psi) and $(psi)^2$. Eigen values and eigen functions. Characteristics of wave functions. Normalization and orthogonality of wave functions. Solution of Schrodinger wave equation. Particle in one dimension box.

## Unit – II

### Photochemistry

Consequences of light absorption, phosphorescence, fluorescence, chemiluminescence and photosensitization. Absorption of light, laws of photochemistry: Grothus-Drapper law, Stark-Einstien law. Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative process (internal conversion, inter system crossing). Quantum yield of photochemical reactions, reason for high and low quantum yield of photochemical equations. Primary and secondary processes, photochemical reactions such as (1) $H_2 + Cl_2$ reaction (2) photolysis of ammonia.

## Unit – III

### Spectroscopy -I

Introduction: Electromagnetic radiation of the spectrum, basic features of different spectrometers, statement of the Born Oppenheimer approximation, degree of freedom.
Rotational spectrum: Diatomic molecules, energy levels of rigid rotator, (semiclassical principles) selection rules, spectral intensity, distribution using population distribution (Maxwell Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotator, isotope effect.
Electronic spectrum: concept of potential energy curves for bonding and anti-bonding molecular orbital's, qualitative description of selection rules and Frank –Condon principle.

## Unit -IV

### Spectroscopy II

Vibrational spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity., determination of force constant, qualitative relations of force constants and bond energy, effect of anharmonic motion and isotopes on the spectrum, idea of vibrational frequencies of different functional groups.
**Raman spectrum:** Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester IV

**Paper IV Analytical chemistry BCHE (H) 404** **45 Hrs (3hrs/Week)**

## Unit I

**Spectrophotometric titrations**

Basic principle, instrumentation, experimental techniques, spectrophotometric analysis of Fe(III), Cu (II) with EDTA, Fe(III) in presence of Al(III) with EDTA and analysis of As(III) and Sb(III) in a mixture.

**Nephelometry & turbidimetry**

General discussion, instrumentation, some nephelometry determination (a) sulphate (b) phosphate.

## Unit II

**Flame emission and atomic absorption spectroscopy**

Basic principle, instrumentation,nebulization, flames and flame temperatures, interferences, flamespectrometric techniques. Determination of Ca and Mg in tap water and traces of lead in ferrous alloys by atomic absorption spectroscopy.

## Unit III

**Atomic emission spectrography**

Spectroscopic sources, instruments for emission spectrographic analysis, qualitative and quantitative spectrographic analysis, qualitative spectrographic analysis of a non ferrous alloy and complex organic mixture. Introduction, principle and instrumentation of plasma emission spectroscopy and sources of plasma.

## Unit IV

**Thermal Analysis**

Thermogravimetry (TG), instrumentation, application, differential thermal analysis (DTA) and differential scanning colorimetry, instrumentation.

# BACHELOR OF SCIENCE
# Subject: Chemistry
# Semester IV

**Chemistry Practical** **BCHE (H) 451** **60 hrs (4 hr/week)**

**Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

Duration 7 hours Max. Marks: 90

| | | |
|---|---|---|
| Experiment no. 1 | Inorganic Chemistry | 25marks |
| Experiment no. 2 | Organic chemistry | 20marks |
| Experiment no. 3 | Physical Chemistry | 25marks |
| | Record | 10 marks |
| | Viva | 10marks |

## Inorganic chemistry

Inorganic preparations (any four) and its characterization of coordination compounds

(a) Cuprous chloride, $Cu_2Cl_2$
(b) Tetrammine copper (II) sulphate
(c) Pyridine complex of Copper
(d) Sodium trioxalato ferrate (III)
(e) Sodium trioxalato chromate (III)

## Organic Chemistry

Simple one step organic preparation **(any four)**

1. Preparation of Acetanilide from aniline
2. Preparation of aspirin from salicylic acid
3. Preparation of o- and p-bromoacetanilide from acetanilide
4. Preparation of o- and p-bromoaniline from o- and p-bromoacetanilide
5. Partial reduction of m-dinitrobenzene into m-nitroaniline
6. Preparation of methyl orange from sulphanilic acid
7. Preparation of m-dinitrobenzene from nitrobenzene

## Physical Chemistry

1. To find the velocity constant of the hydrolysis of methyl acetate catalysed by an acid.
2. To determine the order of saponification of ethyl acetate by NaOH.
3. To find out the strength of HCl and acetic acid in mixture of both, by titrating it against a strong alkali (NaOH) by conductivity method.
4. Determination of equivalent conductivity of an electrolyte at different dilutions

**Viva-Voce and Record**

# BACHELOR OF SCIENCE

## Subject: Chemistry
## Semester V

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)501 | Inorganic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)502 | Organic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)503 | Physical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)504 | Analytical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)551 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given below.

ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
|---|---|---|---|---|
| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration**

**Each Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

**Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21marks for internal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester V

**Max.hrs: 3 hrs.** **Max. Marks: 75**

**Part A-** comprises of ten very short answer questions from all units. Attempt any seven. (It's a compulsory question) 7x2= 14marks

**Part B-** comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21marks

**Total 75 marks**

## Paper I Inorganic Chemistry BCHE (H) 501 45 Hrs (3hrs/Week)

### Unit I

**Inorganic Polymers**

**Silicones**

Classification, preparation and structure of silicones, silicon resin, silicon rubber, silicon fluid, industrial application of silicons.

**Phosphazenes**

Preparation, properties, substitution reaction and structure.

### Unit II

**Metal Clusters**

Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyls and halide clusters, compounds with metal-metal multiple bonds.

**Metal carbonyls**

Preparation, properties and bonding of transition metal carbonyls. Detailed study of mononuclear and poly nuclear carbonyls.

### Unit III

**Organometallic compounds**

Definition and classification of organometallic compounds, synthesis, properties and structures of organometallic compounds of magnesium, aluminium, tin and lead.

### Unit IV

**Metal Ligand Bonding**

Limitations of crystal field theory, molecular orbital theory: octahedral, tetrahedral and square planar complexes, $\pi$- bonding and molecular orbital theory.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester V

**Paper II Organic Chemistry BCHE (H) 502** **45 Hrs (3hrs/Week)**

## Unit I

**Nuclear Magnetic Resonance (NMR) Spectroscopy**

Proton magnetic resonance $^{1}$H-NMR spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin spin splitting and coupling constant, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2 tribromo ethane, ethyl acetate, toluene and acetophenone.Problems pertaining to the structure elucidation of simpleorganic compounds using UV, IR and PMR spectroscopic techniques.

## Unit II

**Organometallic Compounds:**

Organomagnesium compounds: The Grignard reagent- formation, structure and chemical reactions,
Organozinc compounds: formation and chemical reactions.
organolithium compound: formation and chemical reactions.
Organo sulphur compounds **:** nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids.

## Unit III

**Heterocyclic compounds**

Nomenclature, five and six membered hetrocyclic compounds, aromatic character, preparation, reactions chemical reactivity, orientation(electrophilic and nucleophilic substitution reaction) basicity of pyrrole , furan, thiophene and pyridine. Condensed five and six membered hetrocyclic compounds, aromatic character, preparation and reactions of indole, quinoline and isoquinoline.

## Unit IV

**Polymers and Polymerization**

Addition and condensation polymerization, their mechanism, copolymerization, coordination polymerization, Ziegler-Natta catalyst, plastic, thermoplastic and thermosetting resins, plasticizers, polystyrenes, PVC, polyacrylates, polyacrylonitrile, dacron, terylene, nylon-66, Bakelite, melamine and polyurethanes. Elementary idea of the stereochemistry of polymers. Synthetic and natural rubbers.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester V

**Paper III Physical Chemistry BCHE (H) 503** **45 Hrs (3hrs/Week)**

## Unit – I

**Quantum mechanics-II**

Schrodinger's wave equation for particle in three dimensional boxes, H-atom, quantum number and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.

M.O. Theory, basic ideas- criteria for forming M.O. from A.O., construction of M.O.'s by LCAO-$H_2^+$ on, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of sigma, sigma $^*$and $\pi$, $\pi^*$ orbitals and their characteristics. Hybrid orbitals – sp,$sp^2$, $sp^3$ , calculation of coefficients of A.O.'s used in these hybrid orbitals. Introduction to Valence bond model of $H_2$, comparison of M.O. and V.B. model.

## Unit – II

**Systems of variable composition**

Partial molar quantities, dependence of thermodynamic parameters on compositions; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. Free energy of mixing and spontaneity, equilibrium between ideal gases and a pure condensed phase.

## Unit – III

**Physical properties and molecular structure**

Optical activity, polarization (Clausius Mossotti equation), orientation of dipole in the electric field, dipole moment, induced dipole moment, measurement of dipole moment, temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties-paramagnetism, diamagnetism and ferromagnetism.

## Unit – IV

**Electrochemistry-II**

Types of reversible electrodes, gas metal ion, metal-metal ion, metal insoluble salt-anion and redox electrods. Electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, sign convention, electrochemical series and its significance.

Electrolytic and Galvanic cells-reversible and irreversible cells, EMF of a cell and its measurements, calculation of thermodynamic quantities of cell reactions ($\Delta G$, $\Delta H$ and K), polarization,

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester V

**Paper IV Analytical Chemistry BCHE (H) 504** **45 Hrs (3hrs/Week)**

## Unit I

**Electrogravimetry**

Theory, electrode reactions, overpotential, completeness of deposition, electrolytic separation of metals, character of the deposit, electrolytic separation of metals with controlled cathode potential. Electrolytic determinations at constant current-copper and lead. Electrolytic determinations with controlled cathode potential – Antimony, copper, lead and tin in an alloy.

**Coulometry**

Coulometry at controlled potential, separation of Ni and Co by coulometric analysis at controlled potential, coulometry at constant current, coulometry titrations.

## Unit II

**Polarography**

Principle and experimental set-up. Diffusion current and half-wave potential – Qualitative and quantitative applications of polarogaphy in analytical chemistry.

(i) Wave height concentration graph
(ii) Internal standard (Piloton method)
(iii) Standard addition method
(iv) Use of polarography in : (i) Zn and Cu in brass
(ii) Dissolved oxygen in the sample.

## Unit III

**Amperometry**

Amperometric titrations, technique of amperometric titrations with the dropping mercury electrode, titration with the rotating platinum micro electrode, biamperometric titrations.

(a) Modified Voltammetric methods: currnet sampled (TAST) polarography, pulse polarography, differential pulse polarography, cyclic voltammetry, sinusoidal alternating current polarography, stripping voltammetry.

## Unit IV

**Mass spectrometry**

Instrumentation and technique, elementary idea about electron impact, chemical ionization and matrix assisted laser desorption ionization (MALDI), mass spectrometer techniques. principle of fragmentation, molecular ion peak, base peak, isotopic peaks and meatstable ion peak. Determination of molecular formula, mass spectra of alkanes, alkenes, alkynes, cycloalkanes and arenes, alcohols and ethers, aldehydes and ketones.

# BACHELOR OF SCIENCE
# Subject : Chemistry
# Semester V

**Chemistry Practical** **BCHE(H) 551** **60 hrs (4 hr/week)**

**Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

Duration 7 hours Max. Marks: 90

| | | |
|---|---|---|
| Experiment no. 1 | Inorganic Chemistry | |
| | Qualitative analysis | 15marks |
| | Quantitative analysis | 15marks |
| Experiment no. 2 | Organic chemistry | 20marks |
| Experiment no. 3 | Physical Chemistry | 20marks |
| | Record | 10 marks |
| | Viva | 10marks |

## Inorganic chemistry

1. Qualitative analysis of mixture containing six radicals, one of which should be a rare ion. The mixture may contain radicals of any combinations including interfering acid radicals and insoluble.
2. Quantitative estimation of any three of the following mixture by volumetric and gravimetric methods.
    a. Copper-Zinc
    b. Zinc-Nickel
    c. Silver-Copper
    d. Silver-Nickel
    e. Silver-Zinc
    f. Copper-Nickel

## Organic Chemistry

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH and ether for separation and preparation of suitable derivatives.

## Physical Chemistry

### pH metric titrations

1. To find out the strength of strong acids by titrating it against strong base
2. To find out the strength of strong acids by titrating it against weak base
3. To find out the strength of weak acids by titrating it against strong base
4. To find out the strength of HCl and acetic acid in a mixture of both by titrating against NaOH

**Viva-Voce and Record**

# BACHELOR OF SCIENCE

## Subject: Chemistry

## Semester VI

| Paper code | Paper Title | Type of paper | Contact Hours Per semester | Per week | Maximum marks | Minimum marks | ESE in hrs. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Theory | Practical |
| BCHE(H)601 | Inorganic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)602 | Organic chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)603 | Physical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE (H)604 | Analytical chemistry | Theory | 45 | 3 | 75 | 30 | 3 | - |
| BCHE(H)651 | Chemistry Practicals | Lab work | 60 | 8 | 150 | 60 | - | 7 |
| | | | | 20 | 450 | | | |

The details of the courses with code and title assigned are given below.

ESE = End Semester Examination

## SCHEME OF EXAMINATION

## (Semester Scheme)

**Examination scheme**

| Sr. No. | Paper | ESE | CIA | Total |
|---|---|---|---|---|
| 1. | Theory | 70% | 30% | 100 |
| 2. | Practical | 60% | 40% | 100 |

**Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration**

**Each Practical /Lab work 7 hours duration**

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

**Note: Maximum marks for a theory paper is 75 marks which include 54 marks for ESE and 21marks for internal assessment.**

# BACHELOR OF SCIENCE (Hons.)
# Subject:
# Chemistry
# Semester VI

**Max.hrs: 3 hrs.** **Max. Marks: 75**

**Part A**- comprises of ten very short answer questions from all units. (It's a compulsory question) 2x7= 14marks

**Part B**- comprises of eight long answer questions with two questions from each unit. Candidates have to answer any four questions, selecting one question from each unit. 10x4 = 40 marks

**Total marks for End Semester Examination** 54marks

Internal Assessment 21marks

**Total 75 marks**

**PaperI Inorganic Chemistry BCHE(H) 601** **45 Hrs (3hrs/Week)**

## Unit- I

**Nuclear Chemistry I**

Fundamental particles of nucleus (Nucleon), concept of nuclides, representation of nuclides, isotopes, isobars and isotones with specific examples. Applications of radioisotopes, size concept in nucleus and atom. Qualitative idea of the stability of nucleus (n/p ratio).

## Unit- II

**Nuclear Chemistry II**

Shell and liquid drop model, natural and artificial radioactivity, disintegration series, disintegration rates,half life, average life, nuclear binding energy, mass defects, Einstien's mass energy relations, artificial transmutation, nuclear reactions, spallations, nuclear fission and nuclear fusion, nuclear reactors, hazards of radioactive emanations.

## Unit- III

**Bioinorganic chemistry**

Role of bulk and trace metal ions in biological systems with special reference to Na, K, Mg, Ca, Fe, Cuand Zn.

Metalloporphyrins: Chlorophyll and their role in photosynthesis. Haemoglobin and myoglobin and their role as oxygen carriers.

## Unit- IV

**Nitrogen fixation**

Mechanism, nitrogenase enzyme, dinitrogen complexes as models for nitrogen fixation.

**Metalloenzymes**

General discussion of enzymes, functions of metal ions, inhibition (explanation based on coordination chemistry), carboxypeptidase-A and cytochrome-C.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester VI

**Paper II Organic Chemistry BCHE (H) 602** **45 Hrs (3hrs/Week)**

## UNIT I

**Mass Spectrometry**

Introduction, instrumentation, factors influencing fragmentation, ion analysis, ion abundance. fragmentation modes, mass spectral fragmentation of simple organic compounds-alkanes, primary alcohols, aliphatic ketones, aldehydes and carboxylic acids, types of peak: molecular ion peak, isotopic peak, base peak, metastable peak, doubly charged ion, McLafferty rearrangement, retro Diels- Alder fragmentation, nitrogen rule.

## UNIT II

**Carbohydrates**

Introduction, classification, constitution and reaction of glucose and fructose, mutarotation and its mechanism, cyclic structure, pyranose and furanose forms, Haworth projection formulae, configuration of monosaccharide. Determination of ring size, conformation analysis of monosaccharides, epimerization, chain lengthing and chain shortening of aldose, inter conversion of aldoses and ketoses.
Disaccharides: Structure of maltose, lactose and sucrose
Polysaccharides: Structure of starch and cellulose

## UNIT III

**Amino acids, peptides, proteins and nucleic acid**

Classification, structure and stereochemistry of amino acids. Physical properties, Zwitter ion structure isoelectric point and electrophoresis. Preparation and reaction of α amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptides synthesis, solid phase peptide synthesis. Structre of peptides and proteins, levels of protein structure. Protein denaturation / renaturation.

**Nucleic acids**

Introduction, constituents of nucleic acid (RNA and DNA), ribonucleosides and, ribonucleotides. The double helical structure of DNA.

## UNIT IV

**Synthetic dyes**

Color and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluoroscein, Alizarin and Indigo.

**Drugs**

Chemotherapy, Synthetic uses and side effect of analgesics: Aspirin, Phenacetin,Paracetamole.
Antimalarials: Chloroquine, Plasmoquine.
Antibiotic: Chloramphenicol(chloromycetin).
Sulpha drugs and their structure. Synthesis of sulphadiazine, sulphapyridine, sulphathiazole, sulphaguanidine and sulphamethazole.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester VI

**Paper III Physical Chemistry BCHE (H) 603** **45 Hrs (3hrs/Week)**

## Unit-I

**Electrochemistry-III**

Overpotential and overvoltage. Structure of double layer, theories of Helmholtz, Gouy- Chapman and Stern. Concentration cells with and without transport, liquid junction potential, applications of concentration cell, valency of ions, solubility product and activity co-efficient. Potentiometric titrations, determination of pH using hydrogen, quinhydrones and glass electrodes by potentiometric methods. Introduction of polarographic technique.

Classification of electrochemical cells, requirement of power source, lead storage cell and fuel cell. Corrosion- types, theories and methods of combating it.

## Unit II

**Macromolecules**

Linear, branches network and homopolymer

Polymer classification- condensation polymers and addition polymers, number average and weight average, molecular weight determination methods of polymers by (I) Osmotic pressure (II) Viscosity (III) Light scattering. Properties of macromolecules. Electrically conducting polymers, kinetics and mechanism of polymerization.

**Chemical Kinetics**

Catalysis: the simple catalysis mechanism S+C--> SC--> P+C. its mathematical treatment and its consequence. Specific and general acid base catalysis, enzyme catalysis,

## Unit III

**Phase Equilibrium Solid solutions**

Introduction to phase rule including one component and two component systems, compound formation with congruent melting point (Mg-Zn) and benzophenone- dimethylamine incongruent melting point NaCl-$H_2O$, picric acid and benzene, $FeCl_3$-$H_2O$and $CuSO_4$-$H_2O$ system. Liquid-liquid mixtures: ideal liquid mixtures, Roault's law and Henry's law, non-ideal system, azeotropes HCl-$H_2O$ and ethanol-water system. Particularly miscible liquids: phenol water, triethylamine water, nicotine water system, lower and upper consulate temperature. Effect of impurities on consulate temperature Immiscible liquids- steam distillation.

## Unit-IV

**Surface Phenomena, Micelles**

Surface active agents, classification of surface-active agents, micellization, hydrophilic interactions, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion, binding to micelles, thermodynamic of micellization, phase separation and mass action models, solubilization, micro-emulsions, reverse micelles, surface catalysis and mechanism of surface catalysis.

**Adsorption**: Introduction, Gibbs- adsorption isotherm, Freundlich and Langmuir Adsorption Isotherm, estimation of surface area (BET equation), surface films on liquids (electro kinetic phenomenon), catalytic activity at surfaces.

# BACHELOR OF SCIENCE (Hons.)
# Subject: Chemistry
# Semester VI

**Paper IV Analytical Chemistry BCHE (H) 604** **45 Hrs (3hrs/Week)**

## Unit I

**Gas Chromatography and HPLC**

Introduction, gas chromatographs, detectors, programmed temperature gas chromatography, quantitative analysis by GLC, gas-solid chromatography. High Performance liquid chromatographic methods- Adsorption Chromatography, Liquid-liquid partition chromatography, Ion exchange, HPLC, exclusion chromatography.

## Unit II

**Diffraction Pattern**

Fundamental principles, instrumentation, use of X-ray, electron and neutron in diffractommetry and applications of X-ray, electron and neutron diffractometry in biological and as analytical techniques. Applications of X-rays in C.T. scan.

## Unit III

**Automated methods of analysis**

Automatic instruments and automation. Automation of sampling and preliminary sample treatment for air, water and soil, continuous flow method, Discrete methods, automatic analysis based on multilayer films.

## Unit IV

**NMR Spectroscopy**

Theory of nuclear magnetic resonance, experimental methods of NMR spectroscopy, experimental methods of NMR spectroscopy, applications of Proton NMR including applications in MRI technique.

# BACHELOR OF SCIENCE
# Subject: Chemistry
# Semester VI

**Chemistry Practical BCHE (H) 651** **60 hrs (4 hr/week) Practicals**

**Note: Total marks for each semester practicals is 150, which include 90 marks for ESE and 60 marks for internal assessment.**

Duration 7 hours Max. Marks: 90

| | | |
|---|---|---|
| Experiment no. 1 | Inorganic Chemistry | |
| | Inorganic preparation | 15marks |
| | Quantitative analysis | 15marks |
| Experiment no. 2 | Organic Chemistry | 20marks |
| Experiment no. 3 | Physical Chemistry | 20marks |
| | Record | 10 marks |
| | Viva | 10marks |

**Inorganic chemistry**

1. Inorganic preparations (any four) and its characterization of coordination compounds
   a. Bis(dimethylglyoximato)nickel(II) complex
   b. Tetraamminecopper(II) sulphate
   c. cis-Potassium diaquodioxalatochromate(III) complex
   d. Hexaamminenickel(II) chloride
   e. Prussian blue
   f. Chloropentamminecobalt(III) chloride
   g. Carbonatotetraamminecobalt(III) nitrate
2. Analysis of any three of the following
   a. Available chlorine in bleaching powder
   b. Water analysis for total hardness
   c. Analysis of two components
   d. Analysis of cement for Ca, Al or Mg
   e. $MnO_2$ in pyrolusite

**Organic chemistry**

Two step preparation of simple compounds (any three)

a. Preparation of p-aminoazabenzene from aniline
b. Preparation of p-nitroaniline from acetanilde
c. Preparation of syn-tribromobenzene from aniline
d. Preparation of m-nitro aniline from nitrobenzene
e. Preparation of acetanilide from acetophenone (Beckmann Rearrangement)
f. Preparation of anthranillic acid from phthalic anhydride
g. Preparation of eosin from phthalic anhydride

**Physical chemistry**

**A. Potentiometry (Multimeters may also be used)**

1. To determine the strength of a given Ferrous Ammonium Sulphate solution potentiometrically.
2. Determination of dissociation constants of weak acids
3. Determination of number of electrons involved in a cell reaction by setting up concentration cell
4. Determination of transport number of anion by e.m.f. measurements

**B. Spectrophotometer experiments or colorimetric experiments:**

Verify Lambert-Beer's law and determine the concentration of the given aqueous solution of unknown concentration of the salt.

**C. Kinetics:**

1. Determine the effect of ionic strength on the rate of persulphate iodide reaction
2. Determination of molecular weight by Rast Camphor method
3. Determination of concentration of given solution of $H_2SO_4$ by measuring heat changes during dilution
4. Compare the cleansing power of two samples of detergent by surface tension measurements

**Viva-Voce and Record**