

**Nehru Gram Bharati**  
**(Deemed to be University)**

**KOTWA-JAMUNIPUR-DUBAWAL**  
**PRAYAGRAJ-221505**  
**UTTAR PRADESH**

**Department of Chemistry**



*Syllabus for the*  
***Bachelor of Science (Chemistry)***  
***(A Six Semester Course)***  
***Based on Elective course system***  
**Commencing Session: 2019 – 2020**

## **ABOUT THE UNIVERSITY**

**Nehru Gram Bharati (Deemed to be University)** occupies an esteemed place among the rural universities of India for over decades now. Established on 27th June 2008, it is one of the promising institutes in the State of Uttar Pradesh situated at the bank of river Ganges. It was basically conceived by our 1st Prime Minister of India, Late Pt. Jawahar Lal Nehru, who laid the foundation stone of Nehru Gram Bharati on 26th July 1962 in the village of Rishi Durvasha Ashram, Kotwa-Jamunipur, Dubawal Complex of his phulpur constituency in Allahabad District. His dream was translated into reality by Sri J.N. Mishra, who had a clear vision and dedication to the cause of upliftment of rural masses through education.

As on date, the campus has emerged as a prominent establishment of professional, technical education and traditional education for meeting the aspirations of youth from rural as well as urban areas. To begin with Rajiv Gandhi Degree College was established in the year 1996 and upgraded to Rajiv Gandhi Post Graduate College from the academic session 2000-01 which subsequently merged into the Nehru Gram Bharati (Deemed to be University) in 2008-09 after University Grants Commission recommended to the Ministry of Human Resource & Development for granting it Deemed to be University Status. The MHRD notified vide its gazette Notification no. F.9-42/2005-43(A) dated as 27th June 2008 bestowing the Deemed to be University status to Nehru Gram Bharati

**The Nehru Gram Bharati (Deemed to be University)** is composed of six campuses encircling approximately 76 acres of land spread over within a radius of about 5 Kilometers. The campuses are as under:

**Nehru Gram Bharati (Deemed to be University), Jamunipur Main Campus:** The lush green campus has buildings for Administrative Office, Central Library, Faculty of Teacher Education, Arts, Science & Commerce. The Undergraduate Courses viz., Bachelor of Arts (in the subjects Ancient History, Pol. Science, Hindi, Geography, Education, Sanskrit, English, Sociology, Home Science, Economics, Music & Philosophy), Bachelor of Commerce, Bachelor of Science (In Physics, Chemistry, Zoology, Mathematics & Physics), Bachelor of Education(B.Ed.), Bachelor of Special Education (Hearing Impairment), Diploma in Special Education(D.Ed.Spl.Ed.[HI]), Bachelor of Elementary Education (B.El.Ed.), Diploma in Elementary Education (D.El.Ed.) are being offered in this campus. The Post Graduate Courses viz., Master of Arts (In Ancient History, Pol. Science, Hindi, Education, Sanskrit, English, Economics, Sociology, Home Science, Philosophy & Geography), Master of Commerce, Master of Science (In Physics, Chemistry, Zoology, Mathematics and Botany), Master in Education (M.Ed.), Master of Special Education in Hearing Impairment (M.Ed.Spl.Ed.[HI] are being offered in the campus.

**Nehru Gram Bharati (Deemed to be University), Shashi Campus (Research Centre):** The Research Centre is located at Anjaneya Parishar, Jhuthi Tali, Prayagraj to conduct research programmes in various available disciplines for Ph.D. Degree. The departments of Journalism & Mass Communication and Social Work also share a part of the building offering Post Graduate Diploma in Journalism & Mass Communication (PGDJMC), Bachelor of Arts (Journalism & Mass Communication), Master of Arts (Journalism & Mass Communication), & Master of Social Work.

**Nehru Gram Bharati (Deemed to be University), Kamal Goindi Campus :** The campus is situated at a distance of 500 mts. from the Jamunipur main Campus. It houses the Department of Music and Performing Arts and Library & Information

Science offering the degrees of Bachelor in Performing Arts (Vocal & Tabla), Masters in Performing Arts (Vocal & Instruments), Bachelor & Masters degree in Library and Information Science.

**Nehru Gram Bharati (Deemed to be University), Hanumanganj Campus:** The Faculty of Law is located at a distance of around 04 Kms from Jamunipur Main Campus on Prayagraj-Varanasi route offering LL.B. (3 years), B.A.LL.B. (Integrated 5 years) and LL.M. Courses. Department of Computer Application is also a part of Hanumanganj Campus and offers B.C.A., M.C.A. and PGDCA Courses.

**Nehru Gram Bharati (Deemed to be University), Civil Lines Campus:** The Department of Management is placed at Civil Lines Campus of the Deemed to be University offering B.B.A. and M.B.A. Courses.

**Nehru Gram Bharati (Deemed to be University), Sarpatipur Campus:** The Nehru Gram Bharati proposes to start medical education wing in near future.

## **ABOUT THE DEPARTMENT**

The Department of Chemistry is one of the oldest and most prominent departments of NGB. The department was established in 2008 and is placed in Jamunipur campus of Nehru Gram Bharati (Deemed to be University). It started functioning in 2008-2009.

This department earned significant popularity on national/international scenario under the able guidance and headship of Dr S.C. Tiwari, Pro vice chancellor, NGB (DU). The Chemical Laboratories of NGB formed the nucleus of University Department of Chemistry.

The Department offers Credit based elective course system (ECS) in UG and CBCS in PG programme to provide an opportunity to a student to choose courses from the syllabus and flexibility to the programme structure. It also ensures that the student gets a strong foundation in the subject and gains in-depth knowledge.

### **Programmes Duration and Design**

At undergraduate level department offers courses of study for students from both streams viz. Mathematical sciences and Biological sciences. The undergraduate degree courses in chemistry is a six semester spread over three years academic years. At P.G. level, specialization is available in organic, inorganic and physical and M.Sc. degree is a four-semester course spread over two years. The department also offers Ph.D in science in Chemistry.

## **PREAMBLE**

Bachelor of Science (B.Sc.) is an undergraduate course of Nehru Gram Bharati (Deemed to be University). The curriculum is prepared by following the prospectus of various national and international standards. The Six semester elective course system to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and to specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop in-depth

understanding of various aspects of chemistry. The aim of this course is to provide conceptual understanding, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, acquiring the basic concepts for structural elucidation with hyphenated techniques, understanding the fundamental chemical and biological processes and rationale towards computer.

### **THE VISION**

The vision of the university is to nurture and promote youth especially from rural area by providing high quality education and training in keeping with the promise of Late Pt. Jawahar Lal Nehru. Our dream is to build a role model Institution with state of art infrastructure providing right ambience for creativity and stimulation in thinking to generate new ideas for research and application of skill for developing technology for welfare of mankind.

## **ORDINANCE AND REGULATIONS FOR B.Sc. DEGREE PROGRAMME**

### **A. ORDINANCE**

#### **1. The Degree of Bachelor of Science (B.Sc.)**

The Nehru Gram Bharati (Deemed to University) may confer the Degree of Bachelor's Programme in Science on Such candidates who, being eligible for admission to the Bachelor's Degree Programme, have received regular instruction in the prescribed course of study, passed successfully relevant examinations and being otherwise suitable by virtue of their character, have fulfilled such other condition as may be laid down from time to time by the appropriate authorities.

#### **2. Requirement for Admission**

##### **A. Registration:**

(i) Candidates of Bachelor Degree shall first be admitted to the first semester upon the reopening of the University after summer vacation every year.

##### **(ii) Subsequent Registration**

A candidate, who fails to clear a regular course of study during any of the second, third, fourth, fifth and sixth semesters may be registered in the appropriate term of any subsequent year to the semester concerned but within such time as enables him, to complete the study of all semester comprising Bachelor Degree Programme within a maximum period of five years from the date of his/her registration for the first semester.

##### **B. Minimum Qualification For Admission**

(i) Admission to the Bachelor's Degree Programme of study shall be open to those candidates who have passed the 10+2/intermediate exam from any Board (U.P Board/CBCS board/ICSC/or any other Govt. recognized board). Admission shall be made according to merit subject to the fulfillment of eligibility requirement as determined by the University and availability of seats in the Bachelor courses.

##### **C. Conditions of Admission:**

(i) No application for registration to the First Semester shall be entertained unless it is accompanied by:

(a) Original Transfer certificate of a candidate who has been a regular student in any Institution at any time prior to making application for registration in the Faculty.

- (ii) Candidate shall give also a written undertaking to the effect that:
- (a) He/She shall exclusively devote his/her time to the study of courses prescribed for Bachelor's Degree and in particular he/she shall not offer any other course leading to a degree of any description whatsoever, not shall he/she undertake any remunerative work, though with the prior permission of the Faculty, he/she may join certificate of or diploma courses in any foreign language.
  - (b) He/She shall abide by the provision of NGB (DU) Act, Statutes, Ordinances, Regulations and Rules that are framed or may be framed there under and the orders of Officers and authorities of the University and the concerned Faculty from time to time.

### **3. Fees**

The students pursuing Bachelor's Degree Program of study shall have to pay fee as may be prescribed by the University from time to time.

4. The course of study, scheme of examination, result and promotion are covered in the regulation, and are given below.

### **REGULATIONS**

1. The syllabus for B. Sc. based on semester with credit based pattern comprises of six semesters. The examination shall be of Minimum 18 (eighteen) and Maximum 20 (twenty) theory papers and 6 practical. From semester I to IV, each theory and practical will be of 50 marks.
2. During semester V & VI, the marks for theory will be 75 or 50 and the marks of practical will be 75 or 100. The theory papers and practical in semesters I to IV will be of 2 credits, while in V and VI semester, theory will be of 3 or 2 credits and practical will be of 3 or 4 credits respectively. Thus total number of credits from I to IV will be 32 credits while in V and VI semester the number of total credits will be 24 credits. Thus the grand total of credits in B.Sc. will be 56 for each subject.
3. The semester I to IV has 8 credits ( $2 \times 3 = 6$  theory and  $2 \times 1 = 2$  practical, Total=08 credit) and V to VI has 12 credits ( $3 \times 3 = 9$  theory and  $3 \times 1 = 3$  practical, Total 12 credits or  $2 \times 4 = 8$  theory and  $4 \times 1 = 4$  practical, Total=12 credits). There shall be six practical and one seminar/project in complete course. The Examination in each theory paper shall be of three hours duration. The structure of syllabus for B.Sc. (Semester with credit based pattern) is given in the following table.
4. Each semester shall have minimum 90 teaching days, exclusion of holidays, admission and examinations.

### **SCHEME OF EXAMINATION**

1. The evaluation scheme of examination consists of two parts: Internal Assessment (IA) and End Semester Examination (ESE). Internal assessment includes Assignments/Seminars/ Unit test/Group activities/Discussion, etc. The internal assessment will contribute 20% and the end semester examination will contribute 80% to the total marks.
2. There shall be continuous assessment of the student in each course. The course instructor shall hold a maximum of three and minimum of one internal test /assignment /presentation, etc.
3. In case of semester examination, there shall be no binding on the number of external paper setters/examiners, generally the course instructor shall be the paper setter and examiner. The duration of the End Semester Examination (ESE) of each course will be 3 Hours.

**Note: The ratio of internal assessment and end semester examination will be the same as determined by the University.**

## **B. Sc. – CHEMISTRY**

### **(Six-Semester Credit System)**

The syllabus for B. Sc. Chemistry based on semester with credit based pattern comprises of six semesters. The examination shall be of 18 (eighteen) theory papers and 6 practical each of 50 marks from Semester I to IV. During Sem V & VI, the marks for theory and practical will be 75. The theory papers as well as practical in semesters I to IV have 2 credits, while in V and VI semester, theory and practical will be 3 credits in each. Thus total number of credits from I to IV will be 32 credits while in V and VI Sem, the number of total credits will be 24 credits. Thus, the grand total of credits in B.Sc. Chemistry will be 56. The semester I to IV has 8 credits (2X3=6 theory and 2 practical=08 credit) and V to VI has 12 credits (3X3=9 theory, 3 practical=12). The student has freedom to choose paper of his/her choice in semester V and VI. There shall be six practical in complete course and only one seminar in VI Semester. The Examination in each theory paper shall be of three hours duration. The structure of syllabus for B.Sc. Chemistry (Semester with credit elective based pattern) is given in the following table.

**B.Sc. Chemistry**  
**(Semester Wise Breakup structure)**

Sr. No.	Code	Paper	Title	IA	ESE	Total Marks	Credits
<b>Semester I</b>							
1.	BOC 101	Paper I	Inorganic Chemistry-I	10	40	50	2
2.	BOC 102	Paper II	Organic Chemistry-I	10	40	50	2
3.	BOC 103	Paper III	Physical Chemistry-I	10	40	50	2
4.	BOC 104	Practical		10	40	50	2
			Total Credits			200	8
<b>Semester II</b>							
5.	BOC 201	Paper I	Inorganic Chemistry-II	10	40	50	2
6.	BOC 202	Paper II	Organic Chemistry-II	10	40	50	2
7.	BOC 203	Paper III	Physical Chemistry-II	10	40	50	2
8.	BOC 204	Practical		10	40	50	2
						200	8
<b>Semester III</b>							
9.	BOC 301	Paper I	Inorganic Chemistry-III	10	40	50	2
10.	BOC 302	Paper II	Organic Chemistry-III	10	40	50	2
11.	BOC 303	Paper III	Physical Chemistry-III	10	40	50	2
12.	BOC 304	Practical		10	40	50	2
						200	8
<b>Semester IV</b>							
13.	BOC 401	Paper I	Inorganic Chemistry-IV	10	40	50	2
14.	BOC 402	Paper II	Organic Chemistry-IV	10	40	50	2
15.	BOC 403	Paper III	Physical Chemistry-IV	10	40	50	2
16.	BOC 404	Practical		10	40	50	2
						200	8
<b>Semester V</b>							
17.	BOC 501	Paper I	Inorganic Chemistry-V	15	60	75	3
18.	BOC 502	Paper II	Organic Chemistry-V	15	60	75	3
19.	BOC 503EA/503EB	Paper III	A. Physical Chemistry-V or B. Industrial Chemistry-V	15	60	75	3
20.	BOC 504	Practical		15	60	75	3
						300	12
<b>Semester VI</b>							
21.	BOC 601	Paper I	Inorganic Chemistry-VI	15	60	75	3
22.	BOC 602	Paper II	Organic Chemistry-VI	15	60	75	3
23.	BOC603E C/603ED	Paper III	C. Physical Chemistry-VI or D. Analytical Chemistry-VI	15	60	75	3
24.	BOC 604	Practical		15	60	75	3
						300	12



**B.Sc. - SEM-I**  
**Paper -I (BOC-101)**  
**Inorganic Chemistry-I**

**Unit I**

**Atomic Structure:** Bohr and Sommerfield's atomic models, de-Broglie equation, Heisenberg uncertainty principle, Schrodinger wave equation, Significance of wave function, quantum numbers, shapes of s p d and f orbital, Aufbau's principle and electronic configuration of atoms, Pauli's exclusion principle and Hund's rule of maximum multiplicity.

**Unit II**

**Chemical Bonding:** Ionic, Covalent, Coordinate bond, Sigma and pi-bonds, odd electron bonds, hydrogen bond, Van-der Waals Forces and metallic bond. Covalent character in ionic bonds, partial ionic character of covalent bond.

**Unit III**

**Electrode Potential:** Electrode potential and electro-chemical series and its application.

**Unit IV**

**Extraction of Elements:** General principles of extraction and purification of metals. Extraction and isolation of Li, Be and Ra from their minerals.

**Unit V**

**Principles involved in Qualitative and Volumetric analysis:**

- (a) Chemical reactions in qualitative analysis of inorganic mixture.
- (b) General principles of Volumetric analysis, Equivalent weight, normality, molarity, and molality.

**Paper -II (BOC-102)**  
**Organic Chemistry-I**

**Unit I**

**Structure & Bonding:** Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, resonance, hyperconjugation, aromaticity, inductive field effects and hydrogen bonding

**Unit II**

**Mechanism of organic reactions:** Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents electrophiles and nucleophiles. Types of organic reactions, Energy consideration, Reactive intermediates: carbocations, carbanions, free radicals, carbenes, and nitrenes.

**Unit III**

**Stereochemistry of organic compounds:** Concept of isomerism. Types of isomerism. Conformational isomerism: Conformational analysis of ethane and n-butane, conformations of cyclohexane, axial and equatorial bonds, conformation of monosubstituted cyclohexane derivatives. Newman projection and Fischer formulae. Difference between configuration and conformation.

**Unit IV**

**Alkanes and Cycloalkanes:** Methods of formation: (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids) and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes; orientation, reactivity and selectivity. Cycloalkanes: Baeyer's strain theory and its limitations, Ring strain in small rings (Cyclopropane), theory of strainless rings. The case of cyclopropane ring: banana bonds.

**Unit V**

**Arenes and aromaticity I:** Structure of benzene; molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromaticity: The Huckel rule, aromatic ions. Aromatic electrophilic substitution-general pattern of the mechanism, role of  $\sigma$ - and  $\pi$ -complexes with examples.

**Paper-III (BOC-103)**  
**Physical Chemistry-I**

**Unit I**

**Gases I:** Kinetic theory of gases, specific heat ratio  $C_p/C_v$ , derivation of gas laws, Types of molecular velocities, Maxwell law of distribution of velocity (quantitative treatment).

**Unit II**

**Thermodynamics I:** Thermodynamics terms, statement of the first law, thermodynamic reversibility, maximum work, enthalpy of a system, heat capacity at constant volume and at constant pressure. Extensive and intensive properties, state functions and exact differentials, cyclic rule. Variation of internal energy with temperature and volume, enthalpy as a function of temperature and pressure. Relation between  $C_p$  and  $C_v$ .

**Unit III**

**Thermochemistry I:** Heat of reaction, formation, solvation, hydration, dilution. Kirchhoff's equation.

**Unit IV**

**Chemical kinetics I:** Reaction rate, order and molecularity of reaction, zero, first, second and third order reactions. Methods for determining the order of reaction.

**Unit V**

**Electrochemistry I:** Electrolytic conductance: specific conductance, equivalent conductance, molar conductance, variation of conductance with concentration, Kohlrausch's law of independent migration of ions and its applications, conductance ratio, Ionic mobilities, transport number.

**Chemistry Practical-I (BOC-104)**

**Time: 6 Hours (one day) M.M- 50 Marks**

1. Analysis of inorganic mixture (semi-micro) for four radicals including insoluble radicals. - 10 Marks
2. Volumetric Analysis: Determination of Iron using  $K_2Cr_2O_7$  - 07 Marks
3. Detection of elements in organic compounds. – 07 Marks
4. Record and Viva-Voce.- 6+10Marks
5. Internal Assessment- 1

**B.Sc.-SEM-II**  
**Paper -I (BOC-201)**  
**Inorganic Chemistry-II**

**Unit I**

**Periodic table and atomic properties:** Periodic classification of elements, long form of the periodic table. Atomic, covalent and Ionic radii, Ionization potential, electron affinity, Electronegativity including trends in periodic table and applications in predicting and explaining the chemical behaviour, Lattice energy and hydration energy and their relation to solubility of ionic compounds.

**Unit II**

**Coordination Chemistry:** Double salts and coordination compounds, Werner's theory, Sidgwick's concept of effective atomic number (EAN), IUPAC system of nomenclature of coordination compounds. Types and classification of ligands.

**Unit III**

**Chemistry of Zero Group and S-block elements:**

- (a) Isolation and separation of inert gases from air and compounds of inert gases.
- (b) Organometallic compounds of Li, Na, K, Be and Mg. Polymer complexes (Crown ether complexes) of alkali metals.

**Unit IV**

**Preparation, Properties and Uses of:**

- (a) Heavy water, Lithium tetra hydroxy aluminate, Basic beryllium acetate
- (b) Structure and Bonding of:  $\text{H}_2\text{O}_2$ , Basic beryllium acetate,  $\text{Be}(\text{BH}_4)$ , anhydrous beryllium chloride.

**Unit V**

**Principle involved in Volumetric analysis:**

- (a) Application of Coordination compounds in qualitative analysis.
- (b) Solubility product, Common ion effect, Co-precipitation post-precipitation

**Paper –II (BOC-202)**  
**Organic Chemistry-II**

**Unit I**

**Optical isomerism:** Elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature.

**Unit II**

**Geometrical isomerism:** Elementary idea of geometrical isomerism determination of configuration of geometrical isomers. E & Z system of nomenclature, geometrical isomerism in oximes and alicyclic compounds.

**Unit III**

**Alkenes:** Methods of formation, mechanisms and dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination and relative stabilities of alkenes.

Chemical reactions of alkenes: mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, epoxidations, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ . Substitution at the allylic and vinylic positions of alkenes, Diels-Alder reaction.

**Unit IV**

**Alkynes:** Methods of formation. Chemical reactions of alkynes, acidity of alkynes. mechanism of electrophilic and nucleophilic addition reactions, hydroboration Oxidation, metal ammonia reductions and oxidation.

**Unit V**

**Alkyl halides:** Mechanisms of nucleophilic substitution reactions of alkyl halides,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}1$  reactions with energy profile diagrams.

**Aryl halides:** The addition elimination and the elimination addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

**Paper –III (BOC-203)**  
**Physical Chemistry-II**

**Unit I**

**Gases II:** Deviations of real gases from ideal behavior, Van der Waals equation of state, critical constants and their determination. Reference to some other equation of state e.g. Berthelot and Dieterici. Law of corresponding states.

**Unit II**

**Thermodynamics II:** Joule-Thomson effect, Joule- Thomson coefficient, Inversion temperature. Van der Waals equation and J-T effect in real gases. Important thermodynamic quantities (W, Q, E and H) in an isothermal expansion of an ideal gas and adiabatic expansion of an ideal gas. Calculations of various thermodynamic quantities for Vander Waals gases undergoing various operations under different conditions.

**Unit III**

**Thermochemistry II:** Heat of Combustion and neutralisation. Hess's law and its application, Bond energy and resonance energy.

**Unit IV**

**Chemical Kinetics II:** Kinetics of complex reactions, Effect of temperature on reaction velocity. Collision theory of bi-molecular gaseous reactions

**Unit V**

**Electrochemistry II:** Qualitative treatment of the Debye -Huckel theory of strong electrolytes. Bronsted and Lewis acids and bases. pH and pKa, acid-base concept in non- aqueous media, Buffer solutions. Theory of acid-base indicators. Applications of conductance measurements- determination of degree of dissociation, determination of ionic product of water, determination of Ka of acids. Determination of solubility product of a sparingly soluble salt.

**Chemistry Practical (BOC-204)**

**Time: 6 Hours (one day) M.M.- 50 Marks**

1. Analysis of inorganic mixture (semi-micro) for four radicals including interfering radicals. – 10 Marks
2. Volumetric Analysis: - 07Marks  
Iodometry and Iodimetry (determination of Copper, dichromate and arsenious oxide).
3. Detection of elements and functional groups in organic compounds– 07 Marks
4. Record and Viva-Voce- 6+10Marks
5. Internal Assessment- 10 Marks

**B.Sc.-SEM-III  
Paper -I (BOC-301)**

**Inorganic  
Chemistry-III**

**Unit I**

**Shapes of molecules:** Hybridization of orbitals and directional nature of covalent bond, Sidgwick- Powell theory, Shapes of inorganic molecules such as  $\text{BeCl}_2$ ,  $\text{BF}_3$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{OF}_2$ ,  $\text{Cl}_2\text{O}$ ,  $\text{ClO}_2$ ,  $\text{PCl}_3$ ,  $\text{ICl}_3$ ,  $\text{BrF}_5$ .

**Unit II**

**P-Block elements: Characteristics:** Chemical reactivity of elements and group trend, synthesis, properties and structure of their hydrides and halides, Application of redox potential diagrams with reference to N, P, S, Cl, Br and I.

**Unit III**

**P-Block elements Compounds:** Peroxo compounds of B, C and S. Oxyacids of N, P, S and halogens. Interhalogens, pseudohalogens and polyhalides.

**Unit IV**

**Extraction of elements:** Chemical principles involved in the extraction and isolation of the following elements B, Ge, F, Cr, Ni.

**Unit V**

**Gravimetry:** Principles of gravimetric analysis, Co-precipitation, post precipitation and supersaturation.

**Paper –II (BOC-302)**  
**Organic Chemistry-III**

**Unit I**

**Organic spectroscopy I:** Ultraviolet (UV) absorption spectroscopy – absorption laws (Beer-Lambert's law), molar absorptivity, presentation and analysis of UV-spectra, types of electronic transitions, effect of conjugation Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones.

**Unit II**

**Alcohols:** Monohydric alcohols – Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature, Reactions of alcohols.

**Unit III**

**Dihydric and trihydric alcohols:** Methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol-pinacolone rearrangement. Trihydric alcohols – Methods of formation, chemical reactions of glycerol.

**Unit IV**

**Phenols:** Acidic character of phenols, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation, Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben – Hoesch reaction, Lederer – Manassereaction and Reimer – Tiemann reaction

**Unit V**

**Ethers and Epoxide:** Ethers – Williamson's synthesis, Reaction with HX. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reaction of Grignard and organolithium reagents with epoxides.



## Paper -III (BOC-303)

### Physical Chemistry-III

#### Unit I

**Thermodynamics III:** Second Law of thermodynamics, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

#### Unit II

**Chemical Equilibrium I:** Law of mass action and its application to homogeneous and heterogeneous equilibria, Le-Chatelier principle and its application to chemical equilibrium. Degree of dissociation and abnormal molecular weights.

#### Unit III

**Phase Equilibria I and Nernst distribution law:** Phase, component and degree of freedom, derivation of Gibbs phase rule, Thermodynamics derivation of phase rule, phase equilibrium of one component system-water, S u l p h u r .

#### Unit IV

**Electrochemistry III:** Types of reversible electrodes- Gas electrodes, metal-metal ion electrodes, metal- insoluble metal salt electrodes, redox electrodes. Electrode reactions, Nernst equation, derivation of cell E.M.F., single electrode potential, conventional representation of electrochemical cells. e.m.f. of cell and its measurements, Computation of cell e.m.f. reference electrodes, standard electrode potential, sign conventions, electrochemical series and its significance.

#### Unit V

**Colloids:** Preparation of colloids, theories of stability of colloids, Determination of size of colloidal particles, Electrokinetic potential (Zeta potential). Donnan membrane theory and its applications.

#### Chemistry Practical (BOC-304)

**Time : 6 Hours (one day) M.M.- 50 Marks**

1. Gravimetric Analysis: - 08 Marks  
Barium as  $\text{BaSO}_4$   
Iron as  $\text{Fe}_2\text{O}_3$
2. Organic preparation (one step) and crystallization: - 08 Marks  
Oxalic acid  
Osazone formation
3. Physical Chemistry experiments: - 08 Marks  
Experiments of surface tension (using stalagmometer)  
Partition coefficient determination.
4. Records and Viva-Voce- 6+10 Marks
5. Internal Assessment- 10 Marks

**B.Sc. SEM-IV**  
**Paper- I (BOC-401)**  
**Inorganic Chemistry-IV**

**Unit I**

**Shapes of Molecules:** Valence Shell Electron Pair Repulsion (VSEPR) theory, Shapes of inorganic Molecules :  $\text{PCl}_5$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{IF}_7$ ,  $\text{XeF}_2$ ,  $\text{XeF}_4$ ,  $\text{ClO}_4^-$ , MO theory homonuclear and heteronuclear ( $\text{CO}$  and  $\text{NO}$ ) diatomic molecules.

**Unit II**

**d-Block elements:** Transition elements- General Characteristics, Variable oxidation states, Complex formation, colour, magnetic properties and catalytic properties. Comparative account of 3d, 4d and 5d transition metals with respect to their atomic and ionic sizes, stability of oxidation states and magnetic properties.

**Unit III**

**Coordination Chemistry:** Isomerism in coordination compounds, stereochemistry of complexes involving coordination number 4 and 6

**Unit IV**

**Inorganic Compounds-Preparation, Properties and uses**

Boric acid, Borides, Diborane, Silanes, Hydrazine, hydroxylamine, hydrazoic acid, hyponitrous acid, potassium hexacyanoferrate (II) and (III)

**Unit V**

**Inorganic Compounds-** Structure and bonding of Diborane, Borazine, Phosphazene, Dimeric aluminium chloride ( $\text{Al}_2\text{Cl}_6$ ),  $\text{Al}(\text{BH}_4)_3$ , hyponitrous acid, Hydrazoic acid, Nickel carbonyl.

**Paper -II (BOC-402)**  
**Organic Chemistry-IV**

**Unit I**

**Organic spectroscopy II:** Infrared (IR) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR Spectrum fingerprint region; characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

**Unit II**

**Aldehydes and Ketones:** Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1, 3 dithianes, synthesis of ketones from nitriles and from carboxylic acids.

Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevengel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Bayer – Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff – Kishner,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$  reductions, Halogenation of enolizable ketones.

**Unit III**

**Carboxylic acids:** Acidity of carboxylic acids. Effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids and hydroxyl acids.

**Unit IV**

**Carboxylic acid derivatives:** Relative reactivities of acyl derivatives. Interconversion of acid derivatives nucleophilic acyl substitution. Preparation of carboxylic acid derivatives chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

**Unit V**

**Organic compounds of Nitrogen:** Reactions of nitroalkanes. Mechanisms of nucleophilic substitution in of nitroarenes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic neutral and alkaline media. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

## Paper -III (BOC-403)

### Physical Chemistry-IV

#### Unit I

**Thermodynamics IV:** Concept of entropy- entropy as a state function, entropy as a function of  $V$  and  $T$ , entropy as a function of  $P$  and  $T$ , entropy change in various processes, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases and mixing on gases.

#### Unit II

**Chemical equilibrium II:** Equilibrium constant and free energy - Thermodynamic derivation of law of mass action. Reaction isotherm and reaction isochore- Clausius- Clapeyron equation and Clapeyron equation and its applications.

#### Unit III

**Phase equilibrium II:** Phase equilibrium of two component system- solid-liquid equilibrium, simple eutectic-Bi-Cd, Pb-Ag systems, desilverisation of lead. Thermodynamic derivation of the Nernst distribution and its applications .

#### Unit IV

**Electrochemistry IV:** Reversible electrodes and reversible cells, calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $\Delta K$ ), electromotive force and equilibrium constant of cell reaction, E.M.F. of galvanic cells.

Application of E.M.F. measurements, determination of pH using hydrogen, quinhydrone and glass electrodes.

Corrosion-types, theories and methods of combating it.

#### Unit V

**Surface phenomenon:** Physical and chemical adsorption Freundlich adsorption isotherm, Gibb's adsorption isotherm, Langmuir's theory of monomolecular adsorption. B.E.T. theory.

#### Chemistry Practical (BOC-404)

**Time: 6 Hours (one day) M.M.- 50 Marks**

1. Gravimetric Analysis:- **08 Marks**  
Zinc as ZnO  
Copper as CuO
2. Organic preparation (one step) and crystallization:- **08 Marks**  
Picrate formation  
Azo-dye formation
3. Physical Chemistry experiments:- **08 Marks**  
Experiments on viscosity (using viscometer)  
Molecular weight determination of a volatile substance.
4. Records and Viva-Voce - **06+10Marks**
5. Internal Assessment- **10 Marks**

**B.Sc.-SEM-V  
Paper -I (BOC-501)**

**Inorganic  
Chemistry-V**

**Unit I**

**Theories of covalent bond:** Valence bond theory- Heitler-London and Pauling Slater theories. Molecular orbital theory-LCAO method, bonding, non-bonding and anti-bonding molecular orbitals, Molecular orbital energy level diagrams for homonuclear and heteronuclear di-atomic molecules, electronic structure, bond order, bond length, and bond energy.

**Unit II**

**Metals and metallurgy:** Comparative study of the chemistry of the d- block elements and their important compounds: Sc, Y, La, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, Re, Fe, Co, Ni, and platinum metals (Application of reduction potential diagrams where ever necessary).

**Unit III**

**4 f- block elements:** Characteristics-Electronic structure, lanthanide contraction and its consequences, oxidation states, complex formation, magnetic properties, ion exchange and solvent extraction methods of separation of Lanthanides.

**Unit IV**

**Environmental pollution:** Air pollutants, their sources and toxic effects particulates. Water pollutants, greenhouse effects and Acid rain.

**Unit V**

**Bioinorganic chemistry:** Biological role of alkali and alkaline earth metal ions, Nitrogen fixation.

## Paper -II (BOC-502)

### Organic Chemistry-V

#### Unit I

**Organic spectroscopy III:** Nuclear magnetic resonance (NMR) spectroscopy, nuclear shielding, deshielding, chemical shift and molecular structure, spin – spin splitting and coupling constants, area of signals, interpretation of PMR spectra.

#### Unit II

**Organometallic compounds I:** Organomagnesium compounds- the Grignard reagents – formation, structure and chemical reactions. Organozinc compounds : formation and chemical reactions.

#### Unit III

**Heterocyclic compounds I:** Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

#### Unit IV

**Organic synthesis via Enolates:** Acidity of  $\alpha$ -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate : the Claisen condensation Keto – enol tautomerism of ethyl acetoacetate.

#### Unit V

**Carbohydrates:** Monosachharides- Classification of carbohydrates, reducing and non- reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Determination of configuration of Glucose by Fischer's method. Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides.

Disachharides and Polysacharrides- Structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

**Elective Papers**  
**Paper -III (BOC-503EA)**  
**Physical Chemistry-V**

**Unit I**

**Thermodynamics V:** Gibbs functions (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T, Partial molar quantities. Chemical potential, Gibbs-Duhem equation, Chemical potential and other thermodynamic functions. Effect of temperature on chemical potential. Effect of pressure on chemical potential.

**Unit II**

**Chemical Kinetics III:** Steady state approximation, Lindemann's theory of unimolecular reaction, Qualitative treatment of transition state theory of reaction rates, Primary salt effect in ionic reactions.

**Unit III**

**Photochemistry I:** Absorption of light (Jablonski Diagram), Lambert's and Beer's Law and its limitation, Grotthuss-Draper and Einstein's laws of photochemical equivalence, quantum efficiency, reasons for low and high quantum yields..

**Unit IV**

**Electrochemistry V:** polarization, over potential and hydrogen over voltage. Concentration cells with and without transference, liquid junction potential, fuel cells,

**Unit V**

**Nuclear Chemistry I:** Radioactive decay and equilibrium, nuclear reactions, Q value, cross sections, type of reactions, Chemical effects of nuclear transformations. Natural and artificial radioactivity, theory of nuclear disintegration; disintegration and displacement laws, radioactive series.

## **Paper -III (BOC-503EB)**

### **Industrial Chemistry-V**

#### **Unit I**

**Introduction to unit operation:** Conveying, crystallization, distillation, drying, evaporation, filtration, leaching, liquid-liquid extraction, membrane separation, particle size reduction and enlargements, and solid-solid separation.

#### **Unit II**

**Introduction to unit process:** Alkylation, amination, calcination, carbonylation, halogenation, hydrogenation, hydrolysis, nitration, oxidation, and sulphonation .

#### **Unit III**

**Industrial Gases:** Production, uses and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, chlorine, fluorine and ammonia.

#### **Unit IV**

**Inorganic Chemicals:** Production, uses and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, sodium hydroxide, potassium hydroxide, bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

#### **Unit V**

**Cement and Dyes industry:** a) Cement: Classification of cement, ingredients and their role. Manufacture of cement and the setting process, quick setting cements.  
b) Dyes: Introduction, colour and chemical constitution, classification and manufacture.



**Chemistry Practical-V (BOC-504)**

**Time: 6 Hours (one day) M.M- 75 Marks**

1. Inorganic: - **15Marks**  
Paper chromatographic separation of metal ions (binary mixture only)  
Determination of hardness of water by EDTA.
2. Organic: - **15Marks**  
Determination of iodine value of a vegetable oil.  
Determination of saponification value of vegetable oil.
3. Physical - **15 Marks**  
Kinetics of Hydrolysis of an ester catalyzed by an acid.  
Acetone iodine reaction Catalysed by  $H^+$
4. Records and Viva-Voce **05+10 Marks**
5. Internal Assessment- **15 Marks**

**B.Sc.-SEM-VI**  
**Paper-I (BOC-601)**  
**Inorganic Chemistry-VI**

**Unit I**

**Theories of coordinate bond:** Valence bond theory and its limitations, crystal field theory, d- orbital splitting in octahedral and tetrahedral crystal fields, Ligand field splitting ( $10Dq$ ) and factors affecting its magnitude, spectrochemical series. Crystal field stabilization energies (CFSE) for  $d1$  to  $d10$  systems in octahedral and tetrahedral fields.

**Unit II**

**Metals and Metallurgy:** Metallurgical extraction of Ti, Mo, W and Re.

**Unit III**

**Silicones and Phosphazenes:** Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

**Unit IV**

**Structures and Characteristics of Solids:** Metallic, Ionic, and molecular crystals, structures of ionic solid, radius ratio rules, Structure of metals, close-packed structures, characteristics of unit cells.

**Unit V**

**Bioinorganic Chemistry:** Essential and trace elements: Chemistry of chlorophyll, Haemoglobin, Myoglobin and Cyanocobalamin.

## Paper -II (BOC-602)

### Organic Chemistry-VI

#### Unit I

**Organic spectroscopy IV:** Interpretation of PMR spectra of simple organic molecules such as ethylbromide, ethanol, acetaldehyde, 1, 1, 2- tribromoethane, ethyl acetate, toluene and acetophenone.

Problems pertaining to the structure elucidation of simple organic compounds using UV. IR and PMR spectroscopic techniques.

#### Unit II

**Heterocyclic compounds II:** Introduction to condensed five and six – membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bishler-Napleralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

#### Unit III

**Amino acids, Peptides and Proteins:** Amino acids: acids – base behaviour, isoelectric point and electrophoresis,. Reactions of amino acids. Overview of primary, secondary, tertiary and quaternary structure of proteins. Peptide structure determination and group analysis, selective hydrolysis of peptides. Solid – phase peptide synthesis.

#### Unit IV

**Nucleic acids:** Components of nucleic acids: Adenine, Guanine, Thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA.

#### Unit V

**Synthetic polymers:** Addition or chain – growth polymerization Free radical vinyl polymerization ionic vinyl polymerization, Ziegler – Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, Polyamides. Phenol formaldehyde resins, urea– formaldehyde resins and polyurethanes. Natural and synthetic rubbers.

**Elective Papers**  
**Paper -III (BOC-603EC)**  
**Physical Chemistry-VI**

**Unit I**

**Thermodynamics VI:** Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Thermodynamics derivation of the law of mass action, reaction isotherm and Van't Hoff equation (influence of temperature on equilibrium constant). Colligative properties (thermodynamic treatment): Lowering of vapour pressure, osmotic pressure, elevation of boiling point and depression of freezing point.

**Unit II**

**Catalysis:** Kinetics of homogeneous, acid-base and enzyme catalysis, heterogeneous catalysis, negative catalysis and inhibition. Effect of pH and temperature on enzyme catalysis. Effect of temperature on surface reaction. Promoters and poisons.

**Unit III**

**Photochemistry II:** Kinetics of some typical photochemical reactions - Decomposition of acetaldehyde, dimerisation of anthracene, Rice-Herzfeld mechanism for the decomposition of ethane, Photo electric cell, Photosensitization, Chemiluminescence.

**Unit IV**

Atomic structure: Bohr's theory, Sommerfield's model, dual nature of electron, de-Broglie's equation. Experimental verification of the wave nature of electron (Davisson and Germer's experiment). Heisenberg's uncertainty principle. Derivation of Schrodinger's wave equation, Applications of Schrodinger's wave equation, two particle in a one dimensional and three dimensional box and physical significance of the wave function.

**Unit V**

**Nuclear chemistry II:** Nuclear binding energy, nuclear reaction, fission and fusion products and fission yields, radioactive isotopes and their uses. Radioactive techniques: tracer technique, neutron activation analysis, counting technique such as G.M. ionization and preoperational counter.

**Paper -III (BOC-603ED)**  
**Analytical Chemistry-VI**

**Unit I**

**Qualitative and quantitative aspects of analysis:** Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression. Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

**Unit II**

**Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy, UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Transmittance. Absorbance and Beer-Lambert law.

**Unit III**

**Thermal methods of analysis:** Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser

**Unit IV**

**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Chromatography: Classification, principle.

**Unit V**

**Electroanalytical methods:** Classification of electroanalytical methods, basic principle of pH metric, potentiometric titration.

**Chemistry Practical-VI (BOC-604)**

**Time : 6 Hours (one day) M.M.- 75 Marks**

1. Inorganic: - **15 Marks**  
Ion exchange Method- Separation and estimation of Mg and Zn  
EDTA titrations of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$
2. Organic: - **15 Marks**  
Paper chromatographic separation of amino acids and sugars (only binary mixtures)  
Determination of acid value of a vegetable oil.
3. Physical - **15 Marks**  
Heat of neutralization of NaOH and HCl  
To study the effects of acid strength on the hydrolysis of an ester.  
Acid strength on the hydrolysis of an ester.
4. Records and Viva-Voce- **05+ 10 Marks**
5. Internal Assessment- **15 Marks**

**References:**

1. Principle of Inorganic Chemistry- Puri, Sharma, Kalia
2. Concise Inorganic Chemistry- J.D.Lee
3. Modern Organic Chemistry- M.K. Jain, S.C. Sharma
4. Organic Chemistry- Morrison and Boyd
5. Principle of Physical Chemistry- Puri, Sharma, Pathania
6. Physical Chemistry- R.L. Madan
7. Basic Concepts of Analytical Chemistry – S. M. Khopkar, New Age International Publisher.
8. Handbook of Industrial Chemistry- J. A. Kent, Riegel's CBS Publishers, New Delhi.