KUMAUN UNIVERSITY NAINITAL

SYLLABUS FOR SIX SEMESTER (THREE YEAR) B.Sc.
Chemistry Course

Effective from academic year 2017-18

DISTRIBUTION OF DIFFERENT COURSES SEMESTER WISE

There shall be following components of the subject in all the semester courses.

Paper 1 (Theory)		Paper 2 (Theory)		Paper 3 (Theory)		Practical		Total
Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	
60 Marks	20 Marks	60 Marks	20 Marks	60 Marks	20 Marks	45 Marks	15 Marks	300 Marks

Semester wise structure of course
Course Content B.Sc. (Three Year Degree)
Effective from the Academic Year 2017-2018

Odd Semester

First Year Semester I

Paper I	OCH 101	Inorganic Chemistry -1
Paper II	OCH 102	Organic Chemistry - 1
Paper III	OCH 103	Physical Chemistry - 1
Practical	OCH 10P	Chemistry Practical – 1

Second Year Semester III

Paper I	OCH 301	Inorganic Chemistry -3
Paper II	OCH 302	Organic Chemistry - 3
Paper III	OCH 303	Physical Chemistry - 3
Practical	OCH 30P	Chemistry Practical - 3

Third Year Semester V

Paper I	OCH 501	Inorganic Chemistry -5
Paper II	OCH 502	Organic Chemistry - 5
Paper III	OCH 503	Physical Chemistry - 5
Practical	OCH 50P	Chemistry Practical - 5

Even Semester

First Year Semester II

Paper I	ECH 201	Inorganic Chemistry -2
Paper II	ECH 202	Organic Chemistry - 2
Paper III	ECH 203	Physical Chemistry - 2
Practical	ECH 20P	Chemistry Practical - 2

Second Year Semester IV

Paper I	ECH 401	Inorganic Chemistry -4
Paper II	ECH 402	Organic Chemistry - 4
Paper III	ECH 403	Physical Chemistry - 4
Practical	ECH 40P	Chemistry Practical - 4

Third Year Semester VI

Paper I	ECH 601	Inorganic Chemistry -6
Paper II	ECH 602	Organic Chemistry - 6
Paper III	ECH 603	Physical Chemistry - 6
Practical	ECH 60P	Chemistry Practical - 6

Pattern of examination theory papers (for all semesters and each paper I, II and III)

A. Theory

Each theory paper shall consist three sections A, B and C.

***Section A**: (Objective type); 20% of total marks (12 marks, one question of 12 parts each parts of one marks. These parts may have one sentence answers; fill in the blanks, one word. All parts will be compulsory).*

***Section B**: (Short answers type with reasoning); 40% of the total marks (24 marks, six questions of six marks each, any four have to be attempted).*

***Section C**: (Long answers type); 40 % of the total marks, (24 marks, four questions of twelve marks any two have to be attempted).*

B. Internal assessment

For each theory paper an internal assessment (in the form of class test and or assignment including classroom attendance) of 20 marks for each paper which shall be conducted during each semester. Maximum 8 marks can be given to the student having 75% or above attendance. The evaluated answer sheets/assignments have to be submitted to the Head of the department/ Principal along with one copy of award list. Two copies of the award list have to be submitted to the controller examination in a sealed envelope.

C. Practical

The practical work of the students has to be evaluated periodically. The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/home assignment and attendance) of total 15 marks for each semester shall be conducted during the semester. A minimum of 12 experiments covering all kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to students. In each semester practical examination of 45 marks has to be conducted by two examiners (External and internal) having duration of 6 hours. The total number of students to be examined per batch should not be more than sixty. Marks of the practical have to be submitted to the Head of the department/ Principal along with one copy of award list. Two copies of the award list have to be submitted to the controller examination in a sealed envelope.

D. Instructions for paper setter

Note to be mentioned in each theory paper*: This question paper consists of three sections Section A having 12 objective type compulsory questions (one word, one sentence/fill in the blanks) bearing one marks each (20% of the total marks). Section B consists of six short answer type questions with logical approach bearing six marks each. Attempt any four questions from this section (40% of the total marks). Section C consists of four long answer type question carrying 12 marks each. Attempt any two questions from this section (40% of the total marks).Questions are to be attempted section wise sequentially as far as possible. If the student attempts more questions, the marks will be allotted sequentially. The question/questions at the last of sequence is/are considered extra/treated cancelled during the evaluation.*

Semester I Paper I

1. **Subject Code: OCH101 Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-1**
3. **Course Hours Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hours Practical : 6 hours**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of Bohr's theory, its limitation and hydrogen spectra, properties of atom.
8. **Objective of Course :** Students should know
   - Significance of ψ and ψ^2
   - Radial angular wave function
   - Rules of the filling of the orbitals according to the energy levels in the atom like Aufbau principle/Hund's rule.
   - Effective nuclear charge, Shielding effect, Slatter's rules, variation of nuclear charge in periodic table.
   - Atomic, Ionic, Crystal and Covalent radii.
   - Electronegativity, Ionisation energy and enthalpy.
   - Variation of electronegativity with bond order**.**

9. Details of Course:

S.No.	Contents	Contact Hours/ Lectures
1	**Atomic Structure:** Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation (no derivation); significance of ψ and ψ^2. Quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements). Effective nuclear charge.	**8 Lectures**
2	**Periodic Properties** : Atomic and ionic radii, ionization potential, electron affinity, electronegativity-definition, methods of determination/evaluation, trends of variation in periodic table and their application in prediction and explaining the chemical behaviour of elements and compounds thereof.	6 **Lectures**
3	**Redox Reactions-I** Displacement and redox reactions, oxidation state. Balancing of redox reactions (ion-electron and oxidation state methods). Computation of equivalent weights and concept of equivalence.	6 **Lectures**
4	**Chemical Bonding**: Ionic bond, covalent bond-Valence Bond Theory and its limitations; directional nature of covalent bond; various types of hybridization and shapes of different inorganic	8**Lectures**

	molecules and ions. Valence Shell Electron Pair Repulsion Theory (VSEPR) and shapes of NH_3, H_2O, H_3O^+, SF_4, ClF_3, ICl_2^-, NH_4^+, and other simple molecules/ions. Chemistry of xenon; structure and bonding in xenon compounds with oxygen and fluorine.	

Books Recommended:

i. J.D. Lee Concise, Inorganic Chemistry, ELVS.
ii. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher and Distributors.
iii. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
iv. Selected topics in Inorganic Chemistry, Malik, Tuli and Madan, S. Chand & Company, New Delhi**.**
v. Sulekh Chandra, Comprehensive Inorganic Chemistry, New Age International Publications.
vi. Satya Prakash, Modern Inorganic Chemistry, S. Chand & Company, New Delhi

Semester I Paper II

1. **Subject Code: OCH 102 Course Title: B.Sc.**
2. **Subject Area : Organic Chemistry-1**
3. **Course Hours Lecture : L- 30 T: 0 P:20**
4. **Exam Time Theory: 3 hours Practical : 6 hours**
5. **Relative weightage Theory : 80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** Knowledge of concept of bonding and orbitals**.**
8. **Objective of Course :** Students should know

- Types of hybridization sp, sp^2, sp^3 with examples.
- Types of isomerisation and conditions.
- Curve arrow notation and types of organic reactions.
- I.U.P.A.C., R- S-, E and Z Nomenclature with properties of alkanes and cycloalkanes
- Chiral and Achiral molecule and conformational isomerism.

9. Details of Course:

S.No.	Contents	Contact Hours/ Lectures
1	**Structure and Bonding :** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, Van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding	**6 Lectures**
2	**Mechanism of Organic Reactions :** Curved arrow notation,	**8**

	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 considerations. Reactive intermediates- carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).	**Lectures**
3	**Stereochemistry of Organic Compounds** Concepts of isomerism. Types of isomerism-optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centre, 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 systems of nomenclature. Geometrical isomerism: determination of configuration of geometrical isomers, E & Z system of nomenclature, geometrical isomerism in oximes and alicyclic compounds. Conformational isomerism: conformational analysis of ethane and n- butane, conformations of cyclohexane, axial and equatorial bonds, conformations of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer Projection and flying wedge formulae. Difference between configuration and conformation.	**8 Lectures**
	Alkanes and Cycloalkanes : IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: Mechanism of free radical, orientation, reactivity and selectivity. Cycloalkanes- nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-bent or banana bonds.	**8 Lectures**

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.

v. Jagdamba Singh. Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan.
vi. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi.
vii. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester I Paper III

1. **Subject Code: OCH 103 Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-1**
3. **Course Hour Lecture: L 30 T:0 P:20**
4. **Exam Time Theory: 3 hours Practical : 6 hours**
5. **Relative weightage Theory : 80 Practical : 20**
6. **Credits :**
7. **Pre requisite :** Knowledge of physical states of matter, Atom and molecules
8. **Objective of Course** : Students should know
   - Preparation, stability, shape and size of colloids
   - Colloidal dispersion, Emulsion and Gel
   - Equation of state and kinetic theory of gases
   - Types of molecular velocities and Maxwell distribution
   - Deviation of gases from ideal behaviour
   - Definitions and terminology of crystals
   - Laws of crystallography

9. Details of Course:

S.No.	Contents	Contact Hours/ Lectures
1	**Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state. Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquefaction of gases.	**10 Lectures**
2	**Liquid State:** Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity and refractive index. Liquid crystals, difference between liquid crystal, solids and liquids.	**6 Lectures**
3	**Solid State:** Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of	**7 Lectures**

	symmetry. Symmetry elements in crystals, X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).	
4	**Colloidal State:** Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions): types of emulsions, preparation, emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.	**7 Lectures**

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford University Press.
ii. Bell D.W., Physical Chemistry, Thomson Press.
iii. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
iv. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.
v. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi.
vi. Bariyar, Singh and Dwivedi, BSc Chemistry I (combined), Krishna Prakashan Media, Meerut.

Semester I Practical

Practical: OHC10P **Max. Marks: 60**

1. Laboratory hazards and safety precautions
2. Mixture analysis: identification of Acid and Basic Radicals including anions in combination and interfering radicals. Home assignments: problems based on Law of mass action, Le Chatelier Principle; common ion effect, solubility product, pH and buffer solutions, mole concept, molar solution, normal solution, molarity, molality and formality, Calculation for the preparation of standard solutions of acids and bases.
3. Volumetric exercise: acid-base titrations; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. For example: preparation of NaOH solution (secondary standard say N/10), preparation of $(COOH)_2$ solution (primary standard say N/10), standardization of NaOH solution titrating it against $(COOH)_2$ solution using phenolphthalein (indicator) and then determination of the strength of given HCl solution.

   One exercise each from inorganic mixture (qualitative 06 radicals), and volumetric exercise (quantitative) shall be given in the examination.

Distribution of marks shall be as given below:

A.	Inorganic mixture analysis (Acidic and Basic)	24
B.	Volumetric exercise	16
C.	Viva	05
D.	Home assignment/internal assessment, lab record and attendance	15

Note:

- ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
- ***Less than zero mark will not be awarded.***
- ***The total number of students to be examined per batch shall not be more than sixty.***
- ***Duration of the practical examination shall be of 06 (six) hours.***
- ***Marks have to be submitted to the Controller Examination, KU, in a sealed envelope making a copy to the Principal/Head of the department*.**

Semester II Paper I

1. **Subject Code: ECH 201 Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-2**
3. **Course Hours Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hours Practical : 6 hours**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite :** The knowledge of elementary organic chemistry**,**
8. **Objective of Course :** Students should know
    - MO diagrams and bond order of diatomic molecules
    - Fajan's rule
    - Metallic-bond –electron pool
    - Periodic properties of s and p block elements
    - Diagonal relationship
    - Basics of metallurgy
9. **Details of Course**

S.No.	Contents	Contact Hours/ Lectures
1	**Chemical Bonding:** Molecular Orbital Theory (MOT) as applied to diatomic homonuclear/heteronuclear inorganic molecules. MO diagrams and bond order of H2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, Ne_2, CO and NO, difference between VB and MO theories. Multicentre bonding in electron deficient molecules. Polarization of covalent molecules; percentage ionic character from dipole and electronegativity difference. Weak interactions-hydrogen bonding and Van der Waals forces.	**8 Lectures**
2	**Ionic Solids:** Ionic structures, radius-ratio effects and coordination number. Lattice defects, semiconductors, lattice energy and Borne-Haber cycle. Solvation energy and solubility of ionic solids. Polarizing power and polarizability; Fajan's rule. Metallic bond-Electron Pool and MO theories.	**6 Lectures**
3	**s-Block Elements**: General discussion with respect to all periodic	6

	and chemical properties, diagonal relationship, salient features of hydrides, solvation and complexation tendencies, an introduction to their alkyls and aryls. Role of alkali and alkaline earth metal ions in bio-systems.	**Lectures**
4	**p-Block Elements** : General discussion and comparative study (all periodic and chemical properties) including diagonal relationship, of groups 13 to 17 elements; chemistry of elements-hydrides, oxides & oxy-acids, and halides (including inter-halogen compounds). Diborane-properties & structure, borohydrides, carbides, fluorocarbons, basic properties of iodine and polyhalides. Inert-pair effect: in heavier elements of 13, 14 & 15 group elements; its consequences in redox properties of their halides.	8 **Lectures**
5	**Metallurgical Processes:** Minerals & ores; general metallurgical processes-concentration of ores, calcinations, roasting, smelting, slag & flux. Extraction and refining of Lithium and Beryllium.	**2 Lectures**

Books Recommended:

i. J.D. Lee Concise, Inorganic Chemistry, ELVS.
ii. Atkins P.W. Physical Chemistry, Oxford University Press.
iii. Puri, Sharma and Kaliya, Inorganic Chemistry, Vishal Publication.
iv. R.L. Madan, Chemistry for degree students, S. Chand & Company, New Delhi
v. Tuli and Madan, Selected topics in Inorganic Chemistry, Malik, S. Chand & Company**,** New Delhi**.**

Semester II Paper II

1. **Subject Code: ECH 202 Course Title: B.Sc.**
2. **Subject Area : Organic Chemistry-2**
3. **Course Hour Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hour Practical : 6 hour**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite :** The knowledge of Atomic and molecular orbitals,
8. **Objective of Course :** Students should know
    - Nomenclature of alkenes, benzene, alkynes
    - Aromaticity
    - Nomenclature and classification of diene
    - Nomenclature of alkyl halides
    - Mechanism of different types of reactions.
    - Ortho/para orientation
9. **Details of Course :**

S.No.	Contents	Contact Hours/

		Lectures
1	**Alkenes, Cycloalkenes, Dienes and Alkynes** Nomenclature of alkenes , methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff Rule, Hoffmann Elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes; isolated, conjugated and cumulative dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions, Diels -Alder reaction. 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 polymerization.	**12 Lectures**
2	**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 Hückel rule, aromatic ions. Aromatic electrophilic substitution –general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.	**9 Lectures**
3	**Alkyl and Aryl Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides , S_N2 and S_N1 reactions with energy profile diagrams. Polyhalogen compounds - Chloroform, carbon tetrachloride. Methods of formation of aryl halides, nuclear and side chain reaction. The addition-elimination mechanism and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivity of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.	**9 Lectures**

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Sterochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
v. Jagdamba Singh, Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan.
vi. R.L. Madan, Chemistry for Degree students, S. Chand & Company, New Delhi.
vii. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester II Paper III

1. **Subject Code: ECH 203 Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-2**
3. **Course Hour Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hours Practical : 6 hours**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of Chemical reactions and equilibrium.
8. **Objective of Course :** Students should know
   - Catalysis
   - Order and molecularity of reactions
   - Activation energy
   - Thermodynamical coordinates
   - Concept of heat and work.
   - Hess's law of constant heat summation
9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Chemical Kinetics and Catalysis:** Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction– concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates mathematical characteristics of simple reaction – zero order, first order, second order, pseudo order, half life determination of the order of reaction – differential method, method of integration, method of half life period and isolation methods concept of activation energy. Radioactive decay a first order phenomenon. Catalysis, characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.	**15 Lectures**
2	**Thermodynamics I:** Definition of thermodynamic terms, system, surroundings etc. types of systems, intensive and extensive properties, state and path functions and their differentials, thermodynamic process, concept of heat and work, First law of	**15 Lectures**

	thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, Joule – Thomson coefficient and inversion temperature, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible processes, Thermochemistry; standard state, Standard enthalpy of formation – Hess's law of heat summation and its application, heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchoff's equation.	

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford Uni, 2006

ii. Bell D.W. Physical Chemistry, Thomson Press, 2007

iii. R.L. Madan, Chemistry for Degree Students, S. Chand & Company, New Delhi.

iv. Puri and Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher and Distributors, New Delhi.

v. Essential of Physical Chemistry, Bahl and Tuli, S. Chand & Company, New Delhi.

SEMESTER II
B. Sc. Chemistry

Lab Course : ECH 20P

1. Lab Hazards and Safety precautions
2. Determination of surface tension, viscosity, parachor and relative surface tension/viscosity of given liquids.
3. Organic compounds: basic difference between inorganic salts and organic compounds- solubility in water, unsaturation tests; difference between aromatic and aliphatic compounds, determination of MP/BP. Identification of aromatic/aliphatic hydrocarbons, their halogen derivatives, Fusion of organic compound with sodium, preparation of sodium extract- test for the presence of halogens in organic compounds.
4. Home assignments.

One exercise each from organic and physical chemistry experiment shall be given in the examination.

Distribution of marks shall be as given below:

A.	Determination of viscosity and surface tension measurements etc. of given liquids	20
B.	Organic chemistry exercise	20
D.	Viva	05
E.	Home assignment/internal assessment, lab record and attendance	15

Note:

- ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
- ***Less than zero mark will not be awarded.***
- ***The total number of students to be examined per batch shall not be more than sixty.***
- ***Duration of the practical examination shall be of 06 (six) hours.***
- ***Marks have to be submitted to the Controller Examination, KU, in a sealed envelope making a copy to the Principal/Head of the department*.**

Semester III Paper I

1. **Subject Code: OCH301 Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-3**
3. **Course Hour Lecture : L :30 T: 0 P: 20**
4. **Exam Time Theory: 3 hours Practical : 6hours**
5. **Relative weightage Theory: 80 Practical : 20**
6. **Credits :**
7. **Prerequisite:** Knowledge of periodic properties along periods and groups, Types of valency and Theories of valency**.**
8. **Objective of Course :** Students should know
   - The meaning of the terms used in coordination chemistry
   - Acid and base concept
   - Characteristic properties of transition elements, co-ordination number and magnetic properties
   - Second and third transition series
   - Constitution of colouring compounds
9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Chemistry of Transition Elements (First Transition Series):** Characteristic properties of the elements; ionic radii, oxidation states, complex compound formation and magnetic properties. Their binary compounds, illustrating relative stability of their oxidation states, coordination number and geometry.	**8 Lectures**
2	**Chemistry of Transition Elements (Second and Third Series):** General characteristics, comparative treatment with their analogues in respect of ionic radii, oxidation state, magnetic behaviour and stereochemistry.	**5 Lectures**

3	**Acids and Bases:** Arrhenius concept, Bronsted-Lowry concept, Lux-Flood and Lewis concept of acids and bases, role of the solvent and strength of acids and bases. Acid-base properties in non-aqueous media.	**5 Lectures**
4	**Coordination Chemistry-I:** Werner's theory for coordination compounds; its experimental verification, effective atomic number (EAN) concept, chelates. Nomenclature of coordination compounds (IUPAC system), stability of complexes and factors contributing to the stability. Valence Bond Theory (VBT) for coordination compounds, magnetic properties of complex compounds.	**8 Lectures**
5	**Paint industry:** Constitution, colouring compounds.	**4 Lectures**

Books Recommended:

i. J.D. Lee, Concise, Inorganic Chemistry, Wiley & Sons.
ii. Atkins P.W., Physical Chemistry, Oxford Press.
iii. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher & Distributors, New Delhi.
iv. R.L. Madan, Chemistry for degree students. S. Chand & Company, New Delhi.
v. Malik, Tuli and Madan, Selected topics in Inorganic Chemistry, S. Chand & Company, New Delhi.
vi. A.K. De, Text book of Inorganic Chemistry, New Age International.

Semester III Paper II

1. **Subject Code : OCH 302 Course Title: B.Sc.**
2. **Subject Area : Organic Chemistry-3**
3. **Course Hours Lecture : L : T: 0 P: 20**
4. **Exam Time Theory : 3 hours Practical : 6 hours**
5. **Relative weightage Theory : 80 Practical : 20**
6. **Credits :**
7. **Prerequisite :** Knowledge of different class of organic compounds
8. **Objective of Course :** Students should know

- Difference between alcohols and phenols
- Difference between aldehydes and ketones
- Characteristic reactions of functional group of alcoholic, phenolic and carbonyl
- Laws of photochemistry
- Types of electromagnetic radiations and absorption spectroscopy
- Characteristics of functional groups in absorption
- Concept of fingerprint region, intensity and position of IR band
- Grignard's reagent and epoxides

9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Electromagnetic Spectrum: Absorption Spectroscopy** Ultraviolet (UV) absorption spectroscopy-absorption laws (Beer-Lambert 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. Infra Red (IR) absorption spectroscopy- molecular vibrations, Hooke's 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	**7 Lectures**
2	**Alcohols :** Classification and nomenclature. Monohydric alcohols-methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.	**5 Lectures**
3	**Phenols :** Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, Houben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.	**6 Lectures**
4	**Ethers and Epoxides :** Nomenclature, methods of preparation. 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 organo-lithium reagents with epoxides.	**5 Lectures**
5	**Aldehydes and Ketones :** Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis from acid chlorides, synthesis using 1,3-dithianes, from nitriles and carboxylic acids. Physical properties. Mechanism of nucleophilc additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones. An introduction to α-, β-unsaturated	**7 Lectures**

	aldehydes and ketones.	

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Sterochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Sing. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
v. Jagdamba Sing. Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan.
vi. R.L. Madan, Chemistry for Degree Students, S. Chand & Company, New Delhi.
vii. Y.R. Sharma, Elementary Spectroscopy, S. Chand & Company, New Delhi.
viii. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester III Paper III

1. **Subject Code: OCH 303 Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-3**
3. **Course Hour Lecture: L 30 T:0 P:20**
4. **Exam Time Theory: 3 hours Practical : 6 hours**
5. **Relative weightage Theory: 80 Practical :20**
6. **Credits :**
7. **Prerequisite:** The knowledge of thermodynamic terminology, limitations of first law and thermodynamics coordinates**.**
8. **Objective of Course :** Students should know

- Concept of engine
- Different statements of second law of thermodynamics
- Carnot Theorem and Carnot cycle
- Concept of different types of processes and path
- Criteria of spontaneity and different thermodynamic functions
- Meaning of the phase, components and degree of freedom
- Expression of phase rule
- Phase equilibrium of one and two component system
- Raoult's and Henry law
- Non ideal systems and liquid mixtures
- Nernst's distribution law

9. **Details of Course :**

S.No.	Contents	Contact

		Hours/ Lectures
1	**Thermodynamics II :** Second law of thermodynamics, need of the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. 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 physical and chemical processes, entropy change in reversible and irreversible processes. Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmoltz functions. Gibbs function (G) and Helmoltz function (A) as thermodynamic quantities, A and G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T. Gibbs-Helmoltz equation, Clapeyron equation, Clausius-Clapeyron equation, reaction isotherm and reaction isochore.	**12 Lectures**
2	**Chemical Equilibrium:** The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between Kp and Kc. Thermodynamic derivation of the law of mass action, application of law of mass action to some homogenous and heterogeneous equilibrium, Le-Chatelier's principle.	**8 Lectures**
3	**Phase Equilibrium:** Statement and meaning of the terms: phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component systems- water, carbon dioxide and sulphur. Phase equilibria of two component systems: solid-liquid equilibra, simple eutectic; Bi-Cd, Pb-Ag systems, desilverisation of lead. Solid solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point ($NaCl$-H_2O, $FeCl_3$-H_2O and $CuSO_4$-H_2O systems). Freezing mixtures, acetone- dry ice. Liquid-liquid mixtures: ideal liquid mixtures, Raoult's and Henry's law. Non-ideal systems-azeotropes; HCl-H_2O and ethanol-water systems. Partially miscible liquids; phenol-water, trimethylamine-water, nicotine-water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature; immiscible liquids, steam distillation. Nernst distribution law: its thermodynamic derivation and applications.	**10 Lectures**

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford University Press.
ii. Bell D.W. Physical Chemistry, Thomson Press.
iii. R. L. Madan, Chemistry for Degree Students, S. Chand & Campany, New Delhi.
iv. Puri and Sharma, Principal of Physical Chemistry, Milestone Publisher & Distributors, New Delhi..
v. Bahl and Tuli, Essential of Physical Chemistry, S. Chand & Company, New Delhi**.**

SEMESTER III
B. Sc. Chemistry

Practical : OCH 30P

1. Laboratory hazards and safety precautions.
2. Inorganic quantitative analysis-gravimetric estimation of Ba^{2+}, Fe^{3+} Ni^{2+}, Cu^{2+} and Zn^{2+}.
3. Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetraamminecopper(II) sulphate and hexaamminenickel(II) chloride. Crystallization of compounds.
4. Organic qualitative analysis- identification of those classes of organic compounds which are being covered in theory classes (alcohols and phenols, difference among pri-, sec- and tertiary alcohols, aldehydes and ketones).
   Home assignments: based on theoretical aspects of the experiments.

   One exercise each from gravimetric estimation, synthesis of compounds and organic chemistry exercise shall be given in the examination.

   Distribution of marks shall be as given below:

A.	Gravimetric estimation	16
B.	Inorganic Synthesis	08
C.	Organic chemistry exercise	16
D.	Viva	05
E.	Home assignment/internal assessment, lab record and attendance	15

   Note:

   - ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
   - ***Less than zero mark will not be awarded.***
   - ***The total number of students to be examined per batch shall not be more than sixty.***
   - ***Duration of the practical examination shall be of 06 (six) hours.***
   - ***Marks have to be submitted to the Controller Examination, KU, in a sealed envelope making a copy to the Principal/Head of the department*.**

Semester IV Paper I

1. **Subject Code: ECH 401 Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-4**
3. **Course Hours Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hours Practical : 6 hours**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of Periodic properties and redox reactions.
8. **Objective of Course :** Students should know
   - Electrode potential
   - Electrochemical series
   - Properties of Lanthanides and actinides

- Classification of solvents and their characteristics
- Theories and concept of corrosion**.**

9. Details of Course :

S.No.	Contents	Contact Hours/ Lectures
1	**Redox Reactions II :** Standard electrode potential, Reference electrode, determination of electrode potential, electrochemical series, uses of electrode potential data, reaction feasibility and related numerical problems.	**6 Lectures**
2	**Chemistry of Lanthanides :** Electronic structure, oxidation states, ionic radii, lanthanide contraction and its consequences, complex formation, methods of separation of lanthanides-fractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods.	**6 Lectures**
3	**Chemistry of Actinides:** General features of actinides-electronic configuration, atomic and ionic radii, ionization potential, oxidation states and complex formation.	**6 Lectures**
4	**Non Aqueous Solvents:** Classification of solvents, their general characteristics, physical properties of the solvents, reaction in non-aqueous solvents-liquid NH_3 and SO_2 (auto-ionization, precipitation reactions, acid-base reaction, oxidation-reduction reactions, salvation and solvolysis, complex formation), merits and demerits.	**6 Lectures**
5	**Corrosion of metal:** Concept of corrosion, theories of corrosion, types of corrosion, atmospheric and immersed corrosion, protection of metals from corrosion, methods based on treatment of metals and treatment of medium. Passivity of metals; concept of passivity, theories, causes of passivity, electronic interpretation, electro-chemical passivity, applications.	**6 Lectures**

Books Recommended:

i. J.D. Lee Concise, Inorganic Chemistry, Wiley & Sons.
ii. Atkins P.W. Physical Chemistry, Oxford University Press.
iii. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher & Distributors.
iv. R.L. Madan, Chemistry for degree students. S. Chand & Company, New Delhi.
v. Malik, Tuli and Madan, Selected topics in Inorganic Chemistry, S. Chand.
vi. A.K. De, Text book of Inorganic Chemistry, New Age International.

Semester IV Paper II

1. Subject Code: ECH 402 Course Title: B.Sc.

2. **Subject Area : Organic Chemistry-4**
3. **Course Hours** **Lecture: L-30** **T:-0** **P:-20**
4. **Exam Time :** **Theory: 3hours** **Practical : 6 hours**
5. **Relative weightage** **Theory :80 Marks** **Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of aliphatic compounds.
8. **Objective of Course :** Students should know
    - Nomenclature and properties of carboxylic acids and their derivatives
    - Organic synthesis via enolates
    - Chemical reaction of nitrogen containing compounds
    - Nomenclature of alkyl halides
    - Mechanism of esterification and saponification.
    - Azo coupling
9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Carboxylic Acids :** Nomenclature, structure and bonding, physical properties, 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, hydroxy acids-malic, tartaric, and citric acids. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids-methods of preparation and effect of heat and dehydrating agents.	**10 Lectures**
2	**Carboxylic acid derivatives**: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of esterification and hydrolysis (acidic and basic).	6 **Lectures**
3	**Nitrogen Containing Organic Compounds :** Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium. Picric acid. Halonitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. 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, reaction of amines with nitrous acid. Synthetic transformations of aryl	**8 Lectures**

	diazonium salts, azo coupling.	
4	**Organic Synthesis via Enolates :** Acidity of methylene hydrogen, alkylation of diethylmalonate and ethylacetoacetate. Synthesis of ethylacetoacetate, the Claisen condensation. Keto-enol tautomerism of ethylacetoacetate. Synthetic uses of ethylacetoacetate and diethylmalonate.	**6 Lectures**

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Sterochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Sing. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
v. Jagdamba Singh. Undergraduate Organic Chemistry Vol.-I, Pragati Prakashan.
vi. R.L. Madan, Chemistry for Degree Students, S. Chand & Company, New Delhi.
vii. Y.R. Sharma, Elementary Spectroscopy, S. Chand.
viii. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester IV Paper III

1. **Subject Code: ECH 403 Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-4**
3. **Course Hours Lecture: L-30 T:-0 P:-20**
4. **Exam Time : Theory: 3hours Practical : 6 hours**
5. **Relative weightage Theory :80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of metallic conduction and conductors**.**
8. **Objective of Course :** Students should know
   - Electrical conduction and electrolysis
   - Types of electrolytes
   - Transport of ions
   - Debye –Huckel Theory
   - Types of electrodes and cells.
   - Types of adsorption isotherm**.**

9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures

1	**Electrochemistry I:** Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Hückel theory, equation for strong electrolytes (elementary treatment only). Migration of ions, Transport number, definition and determination by Hittorf and moving boundary methods, Kohlrausch's law. Application of conductivity measurements-determination of degree of dissociation, K_a of acids, solubility product of sparingly soluble salts, conductometric titrations.	**12 Lectures**
2	**Electrochemistry II :** Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), polarization decomposition potentials, over potential and hydrogen over voltage. Definition of pH and pK_a, determination pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Mechanism of buffer action, Henderson equation. Hydrolysis of salts.	**12 Lectures**
3	**Surface Chemistry :** Types of adsorption, Freundlich's and Langmuir's adsorption isotherms and their applications, charge on the colloidal particle, size of the colloidal particle, Perrin's method of determination of the Avogadro's number.	**4 Lectures**

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford University Press.

ii. Bell D.W. Physical Chemistry, Thomson Press.

iii. R.L. Madan, Chemistry for Degree Students, S. Chand & Company, New Delhi.

iv. Puri, Sharma and Pathaniya, Principles of Physical Chemistry, Milestone Publisher & Distributors, New Delhi.

v. Bahl and Tuli, Essential of Physical Chemistry, S. Chand.

SEMESTER IV

B. Sc. Chemistry

Lab Course : ECH 40P **Max Marks: 60**

1. Laboratory hazards and safety precautions.

2. Organic qualitative analysis- identification of organic compounds (acids and their halogen derivatives, nitrogen containing compounds- nitro, amines, difference among pri-, sec- and tertiary amines).
3. Volumetric exercises (double titration)- based on redox reactions involving internal as well as external indicators.

Home assignments: based on theoretical aspects of the experiments.

One exercise each from identification of compound and redox titration shall be given in the examination.

Distribution of marks shall be as given below:

A. Organic chemistry exercise	20
B. Volumetric exercise	20
C. Viva	05
D. Home assignment/internal assessment, lab record and attendance	15

Note:

- ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
- ***Less than zero mark will not be awarded.***
- ***The total number of students to be examined per batch shall not be more than sixty.***
- ***Duration of the practical examination shall be of 06 (six) hours.***
- ***Marks have to be submitted to the Controller Examination, KU, in a sealed envelope making a copy to the Principal/Head of the department*.**

Semester V Paper I

1. **Subject Code: OCH 501 Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-5**
3. **Course Hours Lecture : L 30 T: 0 P: 20**
4. **Exam Time Theory : 3 hours Practical: 6 hours**
5. **Relative weightage Theory : 80 Marks Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** Properties of transition metal elements and co-ordination compounds.
8. **Objective of Course :** Students should know

- Stability of metal complexes and co-ordination compounds
- Crystal field theory
- Crystal field splitting in Tetrahedral, Octahedral and Square planner complexes
- Magnetic and spectroscopic properties of transition metal complexes.

9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures

1	**Thermodynamic and Kinetic Aspects of Coordination Compounds:** A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability of coordination compounds. Substitution reactions in square planar complexes.	**6 Lectures**
2	**Metal-Ligand Bonding in transition Metal Complexes :** Limitations of valence bond theory, an elementary idea about crystal field theory; crystal field splitting octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.	**6 Lectures**
3	**Magnetic Properties of Transition Metal Complexes :** Types of magnetic behaviour, methods of determining magnetic susceptibility; Gouy's and Quincke's methods, spin only formula, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.	**6 Lectures**
4	**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, d^4 and d^6, d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.	**6 Lectures**
5	**Electro-analytical Techniques:** Basic concepts of electrogravimetric and coulometric analysis. Thermogravimetric analysis. Voltametry; principle of polarography.	**6 Lectures**

Books Recommended:

i. J.D. Lee Concise, Inorganic Chemistry, Wiley & Sons.
ii. Atkins P.W. Physical Chemistry, Oxford University Press.
iii. Puri, Sharma and Kaliya, Principles Inorganic Chemistry, Milestone Publisher & Distributors, New Delhi.
iv. R.L. Madan, Chemistry for degree students. S. Chand & Company, New Delhi.
v. Malik, Tuli and Madan, Selected topics in Inorganic Chemistry, S. Chand & Company, New Delhi.
vi. A.K. De, Text book of Inorganic Chemistry, New Age International.

Semester V Paper II

1. **Subject Code: OCH 502 Course Title: B.Sc.**
2. **Subject Area : Organic Chemistry-5**
3. **Course Hours Lecture: L 30 T:0 P:20**
4. **Exam Time Theory: 3 hours Practical : 6 hours**
5. **Relative weightage Theory : 80 Practical : 20**
6. **Credits :**
7. **Prerequisite :** Properties of nucleus and protons in a molecules; reactions of organic compounds with metal ions
8. **Objective of Course :** Students should know

- Principles of NMR spectroscopy, magnetic and nonmagnetic nuclei
- Nuclear resonance, chemical shift, shielding and deshielding
- Measurement of chemical shift
- Characteristics of carbohydrates
- Characteristics of organo-sulphur and organometallic compounds

9. Details of Course:

S.No.	Contents	Contact Hours/ Lectures
1	**Spectroscopy :** Nuclear magnetic resonance (NMR) spectroscopy; Proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of pmr spectra of simple organic molecules such as ethyl bromide, 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	**6 Lectures**
2	**Organo-Metallic Compounds:** Organomagnesium compounds; the Grignard reagent-formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions.	**5 Lectures**
3	**Organo-Sulphur Compounds:** Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acid, sulphonamides and sulphaguanidine.	**5 Lectures**
4	**Hetrocyclic Compounds:** 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. Introduction of condensed five- and six membered heterocycles. Preparation and reactions of quinolene and isoquinolene with special reference to Fischer-Indole synthesis, Skraups synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of quinolene and isoquinolene.	**8 Lectures**
5	**Carbohydrates:** Classification and nomenclature. Monosaccharides, mechanism of osazone formation, inetrconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides (structure determination not required). General introduction of structure of ribose and deoxyribose.	**8 Lectures**

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Sing. Reaction mechanism in Organic Chemistry, Macmillan.
v. Elementary Spectroscopy, Y.R. Sharma, S. Chand & Company, New Delhi.
vi. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester V Paper III

1. **Subject Code: OCH503** **Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-5**
3. **Course Hours** **Lecture: L 30** **T:0** **P:20**
4. **Exam Time** **Theory:3 hours** **Practical :6 hours**
5. **Relative weightage** **Theory: 80** **Practical :20**
6. **Credits :**
7. **Prerequisite :** Concept of atomic and molecular structure; Interaction of radiation with matter
8. **Objective of Course :** Students should know
   - Introduction of electromagnetic radiation with molecule
   - Born –Oppenheimer approximation
   - Regions of the spectrum
   - Black body radiation, uncertainty principle
   - Concepts of operators

9. Details of Course :

S.No.	Contents	Contact Hours/ Lectures
1	**Elementary Quantum Mechanics :** Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function.	**12 Lectures**
2	**Spectroscopy :** Introduction; electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation.	**12 Lectures**
3	**Energy and Distribution Law:** Degrees of freedom, types of energies in linear and non-linear molecules, derivation and	**06 Lectures**

	applications of Maxwell-Boltzmann distribution law	

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford University Press.
ii. Bell D.W. Physical Chemistry, Thomson Press,
iii. R.L. Madan, Chemistry for Degree Students, S. Chand & Company.
iv. Puri, Sharma and Pathaniya, Principal of Physical Chemistry, Milestone Publisher & Distributors, New Delhi,
v. Bahl and Tuli, Essential of Physical Chemistry, S. Chand.

SEMESTER V
B. Sc. Chemistry

Practical: OCH 50P **Max Marks: 60**

1. Laboratory hazards and safety precautions.
2. Organic qualitative analysis; binary mixture of organic compounds separable by H_2O.
3. Organic synthesis; through nitration, halogenation, and simple oxidation.
4. Physical chemistry experiments based on solubility and transition temperature.
5. Demonstrative chromatographic experiments; Paper chromatography (analytical separation of simple organic compounds-carbohydrates/Amino Acids).

Home assignments: based on theoretical aspects of the experiments.

One exercise each from organic binary mixture, organic synthesis and physical chemistry experiments shall be given in the examination.

Distribution of marks shall be as given below:

A.	Organic qualitative analysis (water separable binary mixture)	18
B.	Organic synthesis	08
C.	Physical chemistry experiment	14
D.	Viva	05
E.	Home assignment/internal assessment, semester record and attendance	15

Note:

- ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
- ***Less than zero mark will not be awarded.***
- ***The total number of students to be examined per batch shall not be more than sixty.***
- ***Duration of the practical examination shall be of 06 (six) hours.***
- ***Marks have to be submitted to the Controller examination in a sealed envelop making a copy to the Principal/Head of the department.***

Semester VI Paper I

1. **Subject Code: ECH 601** **Course Title: B.Sc.**
2. **Subject Area : Inorganic Chemistry-6**

3. **Course Hour** **Lecture : L-30** **T:-0** **P:-20**
4. **Exam Time :** **Theory: 3hour** **Practical : 6 hour**
5. **Relative weightage** **Theory :80 Marks** **Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of bonding in metals and metal ions.
8. Objective of Course : Students should know
    - Acid base classification
    - Hard and soft acid and bases
    - Nomenclature and classification of organometallic compounds
    - Role of trace elements in biological systems
    - Silicones and polymer of phosphorous
    - Cement and fertilizers.
9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Hard and Soft Acid-Base Theory:** Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness	**6 Lectures**
2	**Organometallic chemistry :** Definition, nomenclature and classification based on nature of metal-carbon bond. Metal carbonyls. Mononuclear carbonyls, nature of bonding, structure and preparation. EAN and 18-electron rule. Definition, nomenclature, classification, general methods of preparation of organometallic compounds and a brief account of metal-ethylenic complexes. Applications of organometallic compounds-Ziegler-Natta catalyst, Wilkinson catalyst (No mechanism).	**6 Lectures**
3	**Bioinorganic Chemistry:** Role of metal ions in biology, essential and trace elements in biological systems, toxic elements, elementary idea of structure and oxygen binding mechanism in metallo-porphyrins with special reference to haemoglobin and myoglobin. Alkali and alkaline earth metal ions in biological system-mechanism of transport across cell membrane, biochemistry of magnesium and calcium	**6 Lectures**
4	**Inorganic Polymers of Silicon and Phosphorus :** Silicones; siloxanes, silicone rubber, polymethylhydrosiloxanes, applications. Phosphazenes, nature of bonding in triphosphazenes. Zeolites.	**6 Lectures**
	Some Industrially Important Inorganic Materials: Cement-Manufacture, composition and setting. Glass- Manufacture, annealing, types and uses. Ceramics-Definition, traditional and new ceramics, structure of ceramics. Inorganic fertilizers-essential nutrients for plants-nitrogenous, phosphatic and potash fertilizers.	**6 Lectures**

Books Recommended:

i. J.D. Lee Concise, Inorganic Chemistry, Wiley & Sons.
ii. Atkins P.W. Inorganic Chemistry, Oxford University Press.
iii. Puri, Sharma and Kaliya, Principles of Inorganic Chemistry, Milestone Publisher & Distributor, New Delhi.
iv. R. L. Madan, Chemistry for degree students. S. Chand.
v. Malik, Tuli and Madan, Selected topics in Inorganic Chemistry, S. Chand.
vi. A.K. De, Text book of Inorganic Chemistry, New Age International.

Semester VI Paper II

1. **Subject Code: ECH 602** **Course Title: B.Sc.**
2. **Subject Area : Organic Chemistry-6**
3. **Course Hour** **Lecture : L-30** **T:-0** **P:-20**
4. **Exam Time :** **Theory: 3hour** **Practical : 6 hour**
5. **Relative weightage** **Theory :80 Marks** **Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of bonding in functional groups and their reactions in organic chemistry**.**
8. **Objective of Course :** Students should know
   - Chemistry of terpenoids
   - Types of polymers
   - Classification of amino acids, proteins and peptides with their properties
   - Soap and detergents
   - Colour and constitution
   - Synthesis and use of dyes**.**

9. Details of Course

S.No.	Contents	Contact Hours/ Lectures
1	**Amino Acids, Peptides, Proteins and Nucleic Acids:** Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α -amino acids. Nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Levels of protein structure. Protein denaturation/renaturation. Nucleic acids: introduction, constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.	**8 Lectures**
2	**Fats, Oils and Detergents :**Natural fats and common fatty acids,	**5**

	glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value and acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.	**Lectures**
3	**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, epoxy resins and polyurethanes. Natural and synthetic rubber.	**6 Lectures**
4	**Synthetic Dyes** : Colour and constitution (electronic concept), classification of dyes. Synthesis and uses of Methyl orange, Malachite green, Phenolphthalein, Fluorescein, Alizarin and Indigo.	5 **Lectures**
5	**Natural Products:** Classification, extraction and general methods of structure determination of terpenoids (limonene, citral) and alkaloids (nicotine, cocaine).	**6 Lectures**

Books Recommended:

i. I.L. Finar, Organic Chemistry, Pearson.
ii. E. L. Eliel, Stereochemistry of Organic Compounds, Willey.
iii. Morrison and Boyd, Organic Chemistry, Prentice-Hall, New Delhi.
iv. S.M. Mukerji and Singh. Reaction mechanism in Organic Chemistry, Macmillan, Reprint.
v. Elementary Spectroscopy, Y.R. Sharma, S. Chand,
vi. G. Marc Loudon, Organic Chemistry, Oxford University Press (Replica press), Kundali, Haryana.

Semester VI Paper III

1. **Subject Code: ECH 603** **Course Title: B.Sc.**
2. **Subject Area : Physical Chemistry-6**
3. **Course Hours** **Lecture: L-30** **T:-0** **P:-20**
4. **Exam Time :** **Theory: 3hours** **Practical : 6 hours**
5. **Relative weightage** **Theory :80 Marks** **Practical : 20 Marks**
6. **Credits :**
7. **Prerequisite:** The knowledge of concept of thermodynamics, energy of photon and optical properties of molecules.
8. **Objective of Course :** Students should know
   - Molecular structure in relation to optical rotation
   - Dipole moments
   - Laws of photochemistry
   - Ideal and non ideal solutions
   - Third law of thermodynamics
9. **Details of Course :**

S.No.	Contents	Contact Hours/ Lectures
1	**Photochemistry :** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert-Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).	**8 Lectures**
2	**Physical Properties and Molecular Structure:** Optical properties and their relation with chemical constitution, polarization, Clausius-Mossotti equation, orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and its application in determining the structure of molecules.	**8 Lectures**
3	**Solutions and Colligative Properties:** Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.	**8 Lectures**
4	**Thermodynamics III :** Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data	**6 Lectures**

Books Recommended:

i. Atkins P.W., Physical Chemistry, Oxford Uni,

ii. Bell D.W. Physical Chemistry, Thomson Press,

iii. R.L. Madan, Chemistry for Degree Students, S. Chand,

iv. Puri, Sharma and Pathaniya, Principal of Physical Chemistry, Milestone Publisher & Distributors, New Delhi.

v. Bahl and Tuli, Essential of Physical Chemistry, S. Chand.

SEMESTER VI
B. Sc. Chemistry

Lab Course : ECH 60P **Max Marks 60**

1 Organic qualitative analysis; binary mixture of organic compounds separable by H_2O and $NaHCO_3$.

2 Organic synthesis; through acetylation, sulphonation and simple oxidation.

3 Physical chemistry experiments based on thermochemistry, phase equilibria. and electrochemistry.

4 Demonstrative chromatographic experiments; Thin Layer chromatography (analytical separation of simple organic compounds)

Home assignments: based on theoretical aspects of the experiments, provide UV,IR and ^{1}H NMR data of identified organic compounds.

One exercise each from organic binary mixture, organic synthesis and physical chemistry experiments shall be given in the examination.

Distribution of marks shall be as given below:

A.	Organic qualitative analysis (binary mixture)	18
B.	Organic synthesis	08
C.	Physical chemistry experiment	14
D.	Viva	05
E.	Home assignment/internal assessment, semester record and attendance	15

Note:

- ***The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during a semester. The semester record has to be maintained by the department/college as an official record.***
- ***Less than zero mark will not be awarded.***
- ***The total number of students to be examined per batch shall not be more than sixty.***
- ***Duration of the practical examination shall be of 06 (six) hours.***
- ***Marks have to be submitted to the Controller Examination, KU, in a sealed envelope making a copy to the Principal/Head of the department.***

Prof. N.D. Kandpal
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