MAHARSHI DAYANAND UNIVERSITY ROHTAK
(Established under Haryana Act No. XXV of 1975)
'A+' Grade University accredited by NAAC

NOTICE FOR INVITING SUGGESTIONS/COMMENTS ON THE DRAFT SYLLABI OF B.A, B.SC., B.COM. UNDER CBCS

Comments/suggestions are invited from all the stakeholders i.e Deans of the Faculties, HODs, Faculties and Principals of Affiliated Colleges on the Syllabi and Scheme of Examinations of B.A, B.Sc., B.Com. Programmes under CBCS (copy enclosed) through e-mail to the Dean, Academic Affairs upto 15.09.2020, so that the same may be incorporated in the final draft.

Dean Academic Affairs

Course : Chemistry
B.Sc. Pass Course (Medical & Non-Medical) 2020-21 under Choice Based Credit System
Programme Specific Outcomes

Chemistry is one of the branch of the science dealing with structure and behaviour of nature with molecular perspective to understand scientific reasoning. The course includes many concepts of inorganic, physical and organic chemistry.

Programme Objectives:

1. Producing graduates who are well grounded in the fundamentals of chemistry and acquisition of the necessary skills, in order to use their knowledge in chemistry in a wide range of practical applications.

2. Helps to create general understanding to become creative and successful chemists in a wide range of professions where logical approach is required.

B.Sc. Pass Course (Medical & Non-Medical)
under Choice Based Credit System
Department of Chemistry

Proposed Scheme of Examinations:

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks	Internal Assessment	Total Marks
I	Ability Enhancement Compulsory Course-I	(English/ Hindi/ MIL Communication)/ Environmental Science	4	80	20	100
	Core Course-I (Theory) DSC 1A	Inorganic Chemistry – I (Atomic structure, Bonding and Chemistry of Main Group Elements)	4	80	20	100
	Core Course-I (Practical/Tutorial)* DSC 1A	Inorganic Chemistry Practical– I	2	50	-	50
	Core Course-II DSC 2A	DSC 2A	6	-	-	150
	Core Course-III DSC 3A	DSC 3A	6 (4+2)/ (5+1)	-	-	150
II	Ability Enhancement Compulsory Course-II	Environmental Science/ (English/ Hindi/ MIL Communication)	4	80	20	100
	Core course-IV (Theory) DSC 1B	Organic Chemistry – I (Basic Organic Chemistry, Stereochemistry and Chemistry of Functional Groups)	4	80	20	100
	Core Course-IV (Practical/Tutorial)* DSC 1B	Organic Chemistry Practical– I	2	50	-	50
	Core Course-V DSC 2B	DSC 2B	6	-	-	150
	Core Course-VI DSC 3B	DSC 3B	6 (4+2)/ (5+1)			150
III	Skill Enhancement Course -1 SEC-1	Green methods in Chemistry	4	80	20	100
	Core Course-VII (Theory) DSC 1C	Physical Chemistry – I (States of matter, Thermodynamics and Chemical Kinetics)	4	80	20	100
	Core Course-VII (Practical/Tutorial)* DSC 1C	Physical Chemistry Practical – I	2	50	-	50
	Core Course-VIII DSC 2C	DSC 2C	6	-	-	150
	Core Course-IX DSC 3C	DSC 3C	6 (4+2)/ (5+1)	-	-	150

IV	Skill Enhancement Course -2 SEC-2	Chemistry of Cosmetics	4	80	20	100
	Core Course-X (Theory) DSC 1D	Inorganic Chemistry-II (Metallurgy, d- and f-block Elements and Cordination Chemistry)	4	80	20	100
	Core Course-X (Practical/Tutorial)* DSC 1D	Inorganic Chemistry Practical– II	2	50	-	50
	Core Course-XI DSC 2D	DSC 2D	6	-	-	150
	Core Course-XII DSC 3D	DSC 3D	6 (4+2)/ (5+1)	-	-	150
V	Skill Enhancement Course -3 SEC-3	Fuel Chemistry	4	80	20	100
	Discipline Specific Elective -1* (Theory) DSE-1A	Chemistry (List attached)	4	80	20	100
	Discipline Specific Elective -1 (Practical) DSE-1A	Lab.	2	50	-	50
	Discipline Specific Elective -2 DSE-2A	DSE-2A	6	-	-	150
	Discipline Specific Elective -3 DSE-3A	DSE-3A	6	-	-	150
VI	Skill Enhancement Course -4 SEC-4	Analytical Chemistry	4	80	20	100
	Discipline Specific Elective -4* DSE-1B	Chemistry (List attached)	4/5	80/120	20/30	100/ 150#
	Discipline Specific Elective -4 (Practical) DSE-1B	(Lab.)/ Tutorials	2/1	50/0	-	50#
	Discipline Specific Elective -5 DSC-2B	DSC-2B	2	50	-	50
	Discipline Specific Elective -6 DSE-3B	DSE-3B	4/5	80/120	20/30	100/ 150#

A. CORE COURSES

1. Inorganic Chemistry-I (4) (Atomic structure, Bonding and Chemistry of Main Group Elements) + Inorganic Chemistry Practical-I (2)
2. Organic Chemistry-I (4) (Basic Organic Chemistry, Stereochemistry and Chemistry of Functional Groups) + Organic Chemistry Practical-I (2)
3. Physical Chemistry-I (4) (States of matter, Thermodynamics and Chemical Kinetics) + Physical Chemistry Practical-I (2)
4. Inorganic Chemistry-II (4) (Metallurgy, d- and f- block Elements and Cordination Chemistry) + Inorganic Chemistry Practical-II (2)

B. *DISCIPLINE SPECIFIC ELECIVE COURSES

a) Discipline Specific Elective-1 (Fifth Semester)
(Select any one of the three options)

1. Spectroscopy and quantum Chemistry
2. Phase Equilibria and Surface Chemistry
3. Bio-molecules and Heterocyclic Chemistry

b) Discipline Specific Elective-4 (Sixth Semester)
(Select any one of the three options)

1. Organic Spectroscopy
2. Electrochemistry
3. Organometalics and Polymer Chemistry

C. SKILL ENHANCEMENT COURSES
(Select any one option out of the three SEC related to disciplines of B.Sc. Pass Course (Medical & Non – Medical Program)

1. Green methods in Chemistry
2. Chemistry of Cosmetics
3. Fuel Chemistry
4. Analytical Chemistry

Programme Outcomes:

1. Students will acquire systematic and coherent understanding of the fundamental concepts in Inorganic, physical and organic chemistry.

2. Students will be able to basic principle of equipments, instrument used in the chemistry laboratory and will be able to demonstrate the experiments techniques and methods in chemistry.

B. Sc. Pass Course (Chemistry)-CBCS

Ist Year (Ist Semester)

Core Course-I :Inorganic Chemistry-I

(Atomic structure, Bonding and Chemistry of Main Group Elements)

Max. Marks: 80 **Credits : 4**

Int. Asst. : 20 **Times : 3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing eight short answer type questions covering the entire syllabus and will be of 2 marks each. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each section. All questions carry equal marks i.e. sixteen.

Course objectives (CO): *The students will understand following concepts:*

1. *Atomic theory, electronic distribution and periodic properties.*
2. *Various types of chemical bonding, theories of bonding, molecular shapes and electronic models.*
3. *Chemistry of main group elements and oxo-acids.*
4. *Noble gas compounds, Structural aspects and applications of Inorganic polymers.*

Unit – I

Atomic Structure: (8 Hours)

Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Periodicity of Elements: (7 Hours)

s, p, d, f block elements. Detailed discussion of the following properties of the elements, with reference to s and p-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii

(c) Ionic radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order.

UNIT - II

Chemical Bonding: (15 Hours)

(i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) Covalent bond: Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. ionic character from dipole moment and electronegativities.

(iii) Metallic Bond: Qualitative idea of free electron model

UNIT – III

Chemistry of s and p Block Elements: (15 Hours)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification, ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Per-oxo acids of Sulphur and inter-halogen compounds.

UNIT – IV

Noble Gases: (7 Hours)

Occurrence and uses, rationalization of inertness of noble gases; preparation and properties of XeF_2, XeF_4 and XeF_6; Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2).

Inorganic Polymers: (8 Hours)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Course Outcomes : *After the completion of this course, students will be able to:*

(i) Understand the basic concepts of atom, its structure and the concept of s, p, d and f orbitals, electronic distribution in atoms and periodic properties.

(ii) Understand nature of chemical bonding, concept of M.O. and the shapes of covalent molecules.

(iii)Understand the Chemistry of main group elements and their important compounds like oxo-acids, boranes, silanes and interhalogen compounds.

(iv) Understand the structure of noble gas compounds, bonding and applications of inorganic polymers.

Recommended Books/References:

1. Lee, J.D. (2008). *Concise Inorganic Chemistry(5th ed.).*USA: Wiley.
2. Douglas, B.E., McDaniel, D.H.& Alexander, J.J.(1999). *Concepts & Models of Inorganic Chemistry (3rd ed.).*New York: John Wiley & Sons.
4. Greenwood, N.N., Earnshaw, A. (1997). *Chemistry of the elements (2nd ed.).* USA: Butterworth-Heinwmann.
5. Cotton, F.A. & Wilkinson, G. (1999). *Advanced Inorganic Chemistry (6th ed.).* VCH: Wiley.

B.Sc. Pass Course (Chemistry) - CBCS

Ist Year (1st Semester)

Core Course-I (Inorganic Chemistry Practical – I)

Max. Marks : 50 **Credits : 2**

Time : 4 Hours

Note: Examiner will give three experiments selecting one from each section. All are compulsory.

Course Objectives(CO) : T*he students will learn following quantitative analysis :*

(i) Estimate oxalic acid, water of crystallization in Mohr's salt, Fe(II) ions and Cu(II) ions by volumetric analysis.

(ii))Estimation of metal ions by redox titrations.

(iii)Estimation of Fe(II)and Cu(II) ions by volumetric titration.

(iv) Concept of estimation of Iodine by titrations.

Section – A (Titrimetric Analysis)

(i) Calibration and use of apparatus.

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(iii) Use of primary and secondary standard solutions.

(iv) Estimation of carbonate and hydroxide present together in mixture.

(v) Estimation of carbonate and bicarbonate present together in a mixture.

(vi) Estimation of free alkali present in different soaps/detergents

Section – B (Iodo / Iodimetric Titrations)

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of (i) arsenite and (ii) antimony iodimetrically

(iii) Estimation of available chlorine in bleaching powder iodometrically.

Section – C (Oxidation-Reduction Titrimetry)

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Distribution of Marks

1. Section A 14 Marks

2. Section B	14 Marks
3. Section C	12 Marks
4. Viva-Voce	5 Marks
5. Lab record	5 Marks

Course Outcomes : *After the completion of this course, students will be able to understand following:*

(i) Separate mixtures of Sodium carbonate and Sodium hydrogen carbonate.

(ii) Determine strengths of Fe(II) solutions with $K_2Cr_2O_7$.

(iii) Determine strengths of Cu(II) solutions iodometrically with $Na_2S_2O_3$.

(iv)Determination of Iodine in solution.

Recommended Books/References:

1. Mendham, J., A. I. Vogel's (2009), Quantitative Chemical Analysis Sixth Edition, Pearson, India.
2. Svehala G. and Sivasankar I. B, Vogel's (2012), Qualitative Inorganic Analysis, Pearson, India.
3. Khosla, B. D.; Garg, V. C. & Gulati, A (2011), *Senior Practical Inorganic Chemistry*, R. Chand & Co. New Delhi.

B.Sc Pass Course (Chemistry) – CBCS
Ist year (2nd Semester)
Core Course-IV: Organic chemistry-I
(Basic Organic Chemistry, Stereochemistry and Chemistry of Functional Groups)

Max. Marks: 80 **Credits: 04**
Int. Asst.: 20 **Time: 3 Hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing eight short answer type questions covering the entire syllabus and will be of 2 marks each. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each section. All questions carry equal marks i.e. sixteen.

Course Objectives (CO): *The students will understand the:*

1. *Basics of organic compounds, structure, bonding, reactivity and reaction mechanisms.*
2. *Different types of aliphatic and aromatic hydrocarbons- synthesis and chemical properties.*
3. *Chemical properties of alcohols, phenols and ethers and their methods of preparation.*
4. *Chemistry of carbonyl compounds and their applications.*

Unit – I

Basics of Organic Chemistry: (9 Hours)

Classification, and nomenclature of organic compounds, hybridization, shapes of molecules and influence of hybridization on bond properties. Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and dipole moment. Organic acids and bases: their relative strength. Electrophiles and nucleophiles, nucleophlicity and basicity.
Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.
Types, shape and relative stabilities of reaction intermediates (carbocations, carbanions, free radicals and carbenes).

Stereochemistry: (6 Hours)

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions. Geometrical isomerism: Cis/trans and syn/anti isomerism, E/Z notations. Optical Isomerism: optical activity, specific rotation, enantiomer, diastreomers, meso compounds, racemic mixture, threo and erythro forms. Molecules with two or more chiral-centres, relative and absolute configuration, D/ L notations, C.I.P. rules: R/S designations.

Unit – II

Carbon-Carbon sigma bond : (5 Hours)

Alkanes: Preparation by catalytic hydrogenation, Wurtz Reaction, Wurtz- Fittig reaction and Corey-House reaction. Mechanism of free radical halogenation of alkanes, orientations, reactivity and selectivity.

Carbon-Carbon pi-bond (10 Hours)

Alkenes: Preparations by dehydration of alcohols, dehydrohalogenation of alkyl halides. Mechanism of elimination reactions(E_1, E_2, E_1CB reactions), Saytzeff and Hoffmann elimination, electrophilic and free radical addition reactions and their mechanisms, Markownikoffs/anti-Markownikoffs rule, mechanism of

hydroboration-oxidation, reduction (catalytic and chemical), oxymercuration-demercuration, ozonolysis, syn- and anti-hydroxylation.

Dienes: Classification of dienes, chemical reactions-1,2 and 1,4 additions, Diels-Alder reaction. Allylic and benzylic bromination and mechanism.

Alkynes: Chemical reactions and acidity of alkynes, electrophilic and nucleophilic addition reactions and their mechanism.

Unit – III

Aromatic hydrocarbons (6 Hours)

Aromaticity, Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Mechanisms of aromatic electrophilic substitution reactions: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation. Activating/deactivating groups and orientations.

Cycloalkanes (2 Hours):

Stability, conformational analysis of cyclohexane and Baeyer strain theory**,**

Chemistry of Halogenated Hydrocarbons (7 Hours):

Alkyl halides: Methods of preparation, mechanism of nucleophilic substitution reactions – S_N1, S_N2 and S_N^i. Nucleophilic substitution vs. elimination.

Aryl halides: Methods of preparation and reactions of aryl halides, addition-elimination and elimination-addition mechanism of nucleophilic aromatic substitution reactions.

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Unit – IV

Alcohols, Phenols, Ethers, Epoxides (6 Hours):

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction. Preparation and properties of glycols, oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation and properties, acidity and factors effecting it, ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Ethers and Epoxides: Preparation and reactions with acids, reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$.

Carbonyl Compounds (9 Hours):

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC) and Michael addition. Active methylene compounds: Keto-enol tautomerism.

Course Outcomes: *On completion of this course, the students will be able to understand:*

1. *Electronic displacements and spatial arrangements, reactive intermediates, electrophile, nucleophiles, hyper conjugation and resonance.*
2. *Preparation and properties of aromatic and aliphatic hydrocarbons, Saytzeff/Hoffmann eliminations.*
3. *Chemical nature of alcohols, phenols and ethers.*
4. *Reactions of carbonyl compounds and their preparations.*

Recommended Books/References:

1. Clayden, J., Greeves, N., Warren S & Wothers P. (2012). *Organic Chemistry* (2nd Ed.). Oxford University Press.
2. Carey, F. A. & Sundberg, R. J. (2007). *Advanced Organic Chemistry Part A: Structure and mechanism*. Springer publications.
3. Morrison, R.N., Boyd R.N. & Bhattacharjee S. K. (2011). Organic Chemistry (7th Ed.) Pearson Education.
4. McMurry, J.E. (2013) Fundamentals of Organic Chemistry (7th Ed.) Cengage Learning.

B. Sc. Pass Course (Chemistry) – CBCS
Ist Year (2nd Semester)
Core Course-IV (Organic Chemistry Practical-I)

Marks: 50 **Time: 4 Hours**
Credit: 02

Note: Examiner will give three experiments selecting one from each section. All are compulsory.

Course objectives (CO): *The students understand the:*

1. *Purification of organic compounds by crystallization and distillation.*
2. *Calibration of thermometer and determination of melting point.*
3. *Basic concept of chromatography and determination of Rf values.*
4. *Preparation of selected organic compounds and calculation of quantitative yields.*

Section – A (Basic Organic Techniques)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Checking calibration of thermometer, determination of melting and boiling points of organic compounds.
3. Separation of mixtures by chromatography: Measures Rf value in each case (combination of two compounds to be given)-

   (a) Separation the components of a given mixture of two amino acids (glycine, aspartic acid, glumatic acid, tyrosine or any other amino acid) by paper chromatography.
   (b) Separation of the sugars present in the given mixture by paper chromatography.
4. To study the process of sublimation of camphor and phthalic acid.

Section – B (Organic Preparation)

Organic preparations: The solid samples must be collected and may be used for recrystallisation, determination of melting point and calculation of quantitative yield.

(a) Nitration of acetanilide/nitrobenzene
(b) Iodoform from ethanol/acetone
(c) Benzoylation of amines/phenols

Section –C (Detection of Hetroatoms and Functional Groups)

Identification of heteroatom and functional groups test for alcohols, phenols and carbonyl compounds.

Distribution of Marks

1. Section A	14 Marks
2. Section B	14 Marks
3. Section C	12 Marks
4. Viva-Voce	5 Marks
5. Lab record	5 Marks

Course outcomes: *After the completion of this course, students will be able to understand:*

1. *Determination of the melting points of compounds.*
2. *Purify organic compounds by recrystallization.*
3. *Separation of components of mixture by chromatographic techniques.*

4. *Synthesis of nitro compounds, iodoform and benzoyl compounds.*

Recommended Books/ references:

1. Furniss, B.S., Hannaford, A. J., Smith, P.W.G. & Tatchell, A.R. (2005). *Vogels Textbook of Practical Organic Chemistry* (5th Ed.). Pearson education.
2. Mann, F.G. & Saunders, B.C. (2009) *Practical Organic Chemistry* (4th Ed.). Person Education.
3. Ahluwalia, V. K & Aggarwal, R. (2000). *Comprehensive practical organic chemistry: Preparation and quantitative analysis*. University Press.
4. Ahluwalia V. K. & Dhingra. S. (2000) *Comprehensive practical organic chemistry: Qualitative analysis*. University Press.