

**M.Sc. Herbal Chemistry (Two years Course)**  
**CHOICE BASED CREDIT SYSTEM**  
**Course Structure**  
**M.Sc. Herbal Ist Semester**

<b>Serial</b>	<b>Course</b>	<b>Code</b>	<b>Description</b>	<b>Credits</b>	<b>Max. Marks (100)</b>
1	Core Course I	MSCHBLCHE CC-1	Inorganic Chemistry – 1	5	100
2	Core Course II	MSCHBLCHE CC-2	Physical Chemistry – 1	5	100
3	Core Course III	MSCHBLCHE CC-3	Organic Chemistry – 1	5	100
4	Core Course IV	MSCHBLCHE CC-4	Physical Chemistry (Lab Course)	5	70+30
5	AECC-1		Environmental Sustainability and Swachchhha Bharat Abhiyan Activities	3+2	50 +50

**M.Sc. Herbal IInd Semester**

<b>Serial</b>	<b>Course</b>	<b>Code</b>	<b>Description</b>	<b>Credits</b>	<b>Max. Marks (100)</b>
6	Core Course V	MSCHBLCHE CC-5	Advanced Herbal Chemistry	5	100
7	Core Course VI	MSCHBLCHE CC-6	Bio-Chemistry	5	100
8	Core Course VII	MSCHBLCHE CC-7	Drug Design & Molecular Modeling	5	100
9	Core Course VIII	MSCHBLCHE CC-8	Bio-Molecules	5	100
10	Core Course IX	MSCHBLCHE CC-9	Herbal Inorganic Chemistry	5	70+30
11	AECC-1			3+2	50 +50

### M.Sc. Herbal IIIrd Semester

Serial	Course	Code	Description	Credits	Max. Marks (100)
6	Core Course X	MSCHBLCHE CC-10	Application of Spectroscopy	5	100
7	Core Course XI	MSCHBLCHE CC-11	Herbal drugs and standardization	5	100
8	Core Course XII	MSCHBLCHE CC-12	Environmental & green chemistry	5	100
9	Core Course XIII	MSCHBLCHE CC-13	Chemistry of medicobotanical plants	5	100
10	Core Course XIV	MSCHBLCHE CC-14	Herbs & Chemical Techniques	5	70+30
11	AECC-2		Human values and professional ethics & Gender Sensitization	3+2	50 +50

### M.Sc. Herbal IV Semester

Serial	Course	Code	Description	Credits	Max. Marks (100)
12	Elective Course (H)I	MSCHBLCHE EC-1	Instrumental and analytical chemistry	5	70+30
13	Elective Course(H) 2	MSCHBLCHE EC-2	Herbal Chemistry Lab Course	5	50+50
14	DSE-1 or GE-1			5	100

**Semester – I**  
**Herbal Chemistry**  
**Core Course - I**  
**INORGANIC CHEMISTRY**

**Full Marks:70**

**Credit -5**

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Group B: Question No.2 will be compulsory comprising five short answer type questions (One from each Unit) any four to be answered. (4x5=20)

Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**UNIT – I: Stereochemistry and Bonding of compounds**

VSEPR Theory,  $d\pi - p\pi$  bond, Bent rule, M.O. diagram for  $\text{CO}_2$ ,  $\text{NO}_2$ ,  $\text{CO}_3$  and Xenon fluoride. Some simple reactions of covalently bonded molecules, electron deficiency and structural aspects of boranes, carboranes, Wade's rule. Metal – Metal multiple bonding.

**UNIT – II: Coordination compounds**

- (a) Crystal field theory. Splitting of d-orbitals in cubic and non-cubic fields. Measurement of  $10Dq$  and factors affecting it.  
Splitting of S,P,D and F terms in Octahedral and Tetrahedral Symmetry.  
Limitation of C.F.T.
- (b) M.O. theory of octahedral complexes with  $\sigma$  and  $\pi$  – bonding ligands using symmetry arguments. Magnetic property and charge transfer spectra on the basis of M.O. model.
- (c) Selection rules for d – d transitions.  
Electronic spectra of  $d^1$ ,  $d^2$ ,  $d^8$  and  $d^9$  system.  
Johan – Teller distortion theory.
- (d) Stepwise and overall stability constants. Determination of stability constant by Bjerrum and Job's continuous variation method.
- (e) Liability and inertness of complexes. Dissociation and Association. Mechanism of substitution reaction in octahedral Co (III) complexes. SN<sub>2</sub>CB reaction mechanism. Theories of transfect. Mechanism of substitution reaction in square planar Pt (II) complexes.

### **UNIT – III: Chemistry of f – Block Elements**

Position in periodic table oxidation states and their stability, Lanthanide and actinide contraction, Magnetic and spectral properties, Separation technique (Ion exchange and Solvent extraction).  
Transuranic elements, Synthesis and Chemistry of Np and Pu, Separation of Pu from Spent fuel.

### **UNIT – IV: Symmetry operation and associated symmetry elements**

Classification of molecules into point groups. Defining properties of a mathematical group, Symmetry operation of a molecule as elements of mathematical group subgroups, conjugate and class.

### **UNIT – IV: Matrix representation for symmetry operation**

Reducible and Irreducible representations, character. The Great orthogonality theorem (activation not required). Consequences of orthogonality theorem, character table construction of character table for  $C_{2v}$  and  $C_{3v}$ . Direct product, reduction formula.

**Semester – I**  
**Herbal Chemistry**  
**Core Course – II**  
**PHYSICAL CHEMISTRY**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**UNIT – I : Solid State**

- (a) Crystal symmetry. Determination of lattice type and unit cell dimensions of NaCl and KCl crystals. Structure factor and crystal analysis of cubic crystal system.
- (b) Imperfection in solid substances.
- (c) Energy band theory of metals and their electronic properties. Super conductors and photoelectric effect.
- (d) Classification of materials based on magnetic properties.

**UNIT – II : Quantum Chemistry**

- (a) Postulates of Quantum mechanics. Different types of operators and their properties Angular momentum operators, their Eigen function and Eigen values.
- (b) Linear Harmonic vibrations, Hermite differential equation and its solution through recursion relation.
- (c) Separation of  $r$ ,  $\theta$  and  $\Phi$  equations for hydrogen and hydrogen like atoms. Laguerre and Associated Laguerre Polynomials.  
Legendre differential equation. Probability density, atomic orbitals and spin orbitals.

### **UNIT – III : Chemical Thermodynamics**

- (a) Partial Molar Properties: Free energy, entropy, enthalpy, volume, etc in ideal gas mixture  
Variation of chemical potential with temperature and pressure. Determination of chemical potential. Gibbs – Duhem equation. Fugacity and activity, the variation with T and P. Fugacity of a gas mixture. Lewis – Randall rule and its significance.
- (b) Thermodynamics of ideal and non-ideal solutions. Duhem – Margules equation and its application.  
Colligative properties using the concept of chemical potential.
- (c) Entropy and Thermodynamic Probability. Boltzmann – Planck equation. Concept of energy distribution. Boltzmann distribution law. Partition function and its significance Relation between thermodynamic functions and partition functions. Sakur – Tetrode equation.

### **UNIT – IV : Chemical kinetics**

- (a) Mechanism and consecutive, opposing and side reactions.
- (b) Evaluation of activation parameters ( $\Delta E^*$ ,  $\Delta H^*$ ,  $\Delta G^*$ ,  $\Delta S^*$ , etc.) Activated complex.  
Theories of Unimolecular reactions.
- (c) Mechanism and kinetic of photolysis of scetaldehyde acetone and photo dimerisation of anthrasene

### **UNIT – V : Electrochemistry**

- (a) Electrode potential in terms of chemical potential and activity; thermodynamics of cell reaction.
- (b) Debye – Huckel – Onsager treatment and its extension, ion solvent interactions, Debye – Huckel – Jerum mode.
- (c) Over potential, exchange current density. Derivation of Butler – volume equations, Tafel – plot.
- (d) Polarography theory, Ilkovic equation, half wave potential and its significance.

**Semester – I**  
**Herbal Chemistry**  
**Core Course – III**  
**ORGANIC CHEMISTRY**

**Full Marks:70**

**Credit -5**

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Group B: Question No.2 will be compulsory comprising five short answer type questions (One from each Unit) any four to be answered. ( $4 \times 5 = 20$ )

Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered ( $3 \times 10 = 30$  marks)

**UNIT – I: Nature of Bonding in Organic Chemistry**

Delocalized chemical bonding – conjugation, cross conjugation, resonance, hyper – conjugation, bonding in fullerenes, tautomerism.

Aromaticity in benzenoid and non benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level or  $\pi$  molecular orbitals, annulenes anti-aromaticity, PMO approach.

Bonds weaker than covalent – addition compounds and crown ether complexes.

**UNIT – II: Stereochemistry**

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity enantiotopic and diastereotopic synthesis. Optical activity in the absence of chiral carbon (biphenyl, allenes and spiranes), chirality due to helical shape.

Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Elementary idea of optical rotator dispersion and circular dichroism.

**UNIT – III: Reaction Mechanism: Structure and Reactivity**

Types of mechanism, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin Hammett principle, Potential energy diagram, transition states and intermediates, methods of determining mechanisms, isotope effect, Hard and Soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity, resonance and field effects, steric effect. The Hammett equation and linear free energy relationship, substituent and reaction constants.

#### **UNIT – IV: Aromatic substitution**

The arenium ion mechanism, orientation and reactivity, energy profile diagram, the o/p ratio, orientation in other ring systems. The  $S_NAr$ ,  $S_N1$ , benzyne mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet – Hauser and Smiles rearrangement.

#### **UNIT – V: Free radical reactions**

Free radical substitution mechanism, mechanism at an aromatic substrate, reactivity for aliphatic and aromatic substrates at bridgehead. The effect of solvent on reactivity. Allylic halogenations. Oxidation of aldehydes to carboxylic acids. Coupling of alkynes and arylation of aromatic compounds and active alkenes by diazonium salts, Sandmeyer reaction, Hunsdiecker reaction.

#### **UNIT – VI: Addition to C=C and C≡C bonds**

Mechanistic and stereochemical aspects of addition reactions involving electrophile, nucleophile and free radicals, regio-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, Hydroboration, Michael Addition.

Addition to C = O bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids and esters. Wittig reaction. Aldol condensation, Knoevenagel reaction, Claisen reaction, Mannich reaction, Benzoin condensation, Perkin reaction and Stobbe reaction.

#### **UNIT – VII: Elimination reactions**

The  $E_1$ ,  $E_2$  and  $E_1c$  mechanism, orientation of the double bond, Reactivity- effects of substrate structure, attacking base, the leaving group and the medium, Mechanism and orientation in pyrolytic elimination.



**Semester – I**  
**Herbal Chemistry**  
**Core Course – IV**

**PRACTICAL PHYSICAL CHEMISTRY**

**Full Marks:70**

**Credit -5**

1. Determination of ebullioscopic constant for water using a solid compound of known molecular weight and then to determine the molecular weight of an unknown compound.
2. Determination of cryoscopic constant of water using compound of known molecular weight and then to determine the molecular weight of unknown compound.
3. Water equivalent of calorimeter and determination of
  - (i) Heat of solution of potassium nitrate.
  - (ii) Heat of neutralization of strong acid and strong base.
  - (iii) Basicity of polybasic acids.
4. Determination of rate constant of hydrolysis of methyl acetate in acid medium.
5. To study saponification of ethyl acetate by sodium hydroxide and determination of rate constant.
6. To determine the distribution coefficient of
  - (i) Acetic acid
  - (ii) Benzoic acidbetween water and benzene by partition method.
7. Determination of specific and molecular rotation of sucrose in different concentrations and to determine the concentration of given solution.
8. Determination of rate constant for inversion of cane sugar polarimetrically.
9. Conductometric experiments:
  - (i) Dissociation constant of acetic acid.
  - (ii) Acid-base titration of NaOH and HCl solutions.
  - (iii) Mixture of HCl and CH<sub>3</sub>COOH with NaOH.
  - (iv) Solubility product of sparingly soluble salt.
10. Potentiometric experiments:

Determination of

  - (i) EMF of concentration cell
  - (ii) pH of a given solution using Hydrogen electrode and quinhydrone electrode.
  - (iii) Acid base titration.
  - (iv) Precipitation titration.

**Distribution:**

One experiment	-	40 Marks
Record	-	10 Marks
Viva – voce	-	20 Mark

**Semester – II**  
**Herbal Chemistry**  
**Core Course – V**  
**Advanced Herbal Chemistry**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**UNIT – I**

Utilization of Bio-organic and Bio-Inorganic Chemistry in Herbal Medicines and Nutritious foods including fruits, vegetables and cereals as preventives from different ailments.

**UNIT – II**

Herbals Medicines utilized specifically in the treatment of Cancer and related diseases of different parts of bodies and their chemistry (studies of selected plants to be made).

**UNIT – III**

Herbal Medicines utilized specifically in the treatment of cold, cough, fever diabetes and heart problems (Studies of selected Herbs e.g. amla, arjuna, aswagandha etc.)

**UNIT – IV**

Herbals Medicines utilized for kidney and liver problems including the stone formation (Details of some herbs viz. Kurthi etc to be studied)

**UNIT – V**

**Nano Science**

Defination, Sources, examples of nanomaterials. Synthesis, Characterisation and applications

**Semester – II**  
**Herbal Chemistry**  
**Core Course – VI**  
**Bio-Chemistry**

**Full Marks:70**

**Credit -5**

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**UNIT – I**

Herbals utilized for Nutritious values in our food. Some Herbal plants to be studied chemically as future supplement for Vitamins. Hormones and Mineral supply to the Human Society.

Students will have to go through Aurvedic. Tibbi and Homeopathy Books, Economic Botany and Biodiversity for prominent medicines utilized for above diseases and other purposes under the guidance of teachers for systematic position botanical names, family, parts of the plants used and chemical principles of the plants studied in different units.

**UNIT – 2**

**Plant Pigments:** Classification of pigments – Their occurrence, Nomenclature, Isolation, Properties, tests for their identification, functions in plants and physiochemical utilization as antioxidants etc. Bio-synthesis of chlorophyll, Carotenoids, Flavone, isoflavones, Flavanol, anthocyanines, anthocyanidins and coumarins.

**Unit – 3: Natural Oxygen Carrier**

Haemoglobin, Myoglobin, Hemocyanin and hemerythrin. Synthetic oxygen carrier-complex of Cobalt and Iron, Cytochrome-P-450, cytochrome-C, Rubredoxins and ferredoxins, Copper blue proteins, Non haeme proteins ferritin and transferrin, metallozymes, fixation of nitrogen. Haeme proteins and oxygen uptake, structure and function of Haemoglobin, myoglobin and hemocyanins.

#### **Unit – 4: Enzymes Properties**

Specificity, enzyme kinetics, Michalis-Menten equation, steady state kinetics, inhibition, Transition state theory, orientation and steric effect, Coenzymes-cofactors as derived from Vitamins, prosthetic groups, thiamine pyrophosphate, pyridoxal phosphate, NAD, NADP, FMN, FAD, Lipoic acid and vit B<sub>12</sub>.

#### **Unit – 5: Bioenergetics**

STd. Free energy change in biochemical reactions, hydrolysis of ATP, Synthesis of ATP, entropy change in biological process.

#### **Unit – 6: Carbohydrate Metabolism**

Calvin cycle, Krebs cycle, Glycolysis, glucogenesis, glycogenolysis, gluconegensis, biosynthesis of disaccharides and polysaccharides. Pentose phosphate pathway.

**Semester – II**  
**Herbal Chemistry**  
**Core Course – VII**  
**Drug Design & Molecular Modeling**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit – I:**

History of the drug design, current trends and future of drug design diseases target validation, Biomolecular interactions. Receptors and enzymes, lead discoveries and modification, pharmacophores, pharmacokinetics (ADME)

**Unit – II:**

Enzyme mechanisms, Enzyme Kinetics and inhibition, Enzyme Inhibition, Reversible inhibitors, TSA Irreversible inhibitors, Mechanism based inactivators. Drug-receptor interactions, Pharmacodynamics.

**Unit –III:**

Structure based drug design: Theoretical foundations, Docking, FEP. Virtual screening, Medicinal and combinational chemistry. **QSAR**: Theoretical foundations, applications.

**Unit IV: INTRODUCTION TO MOLECULAR MODELLING**

Introduction to Molecular Modeling. Models used, Areas of application – Single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co-ordinate systems two – matrix, potential energy surface.

## **Unit V: EMPIRICAL FORCE FIELD MODELS**

Molecular Mechanisms, energy calculations, Bond stretch, angle bending, torsional term. Electrostatic interaction- Van der waals interactions. Miscellaneous interaction.

## **Unit VI – MOLECULAR DYNAMICS**

Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching, Systematic search. Applications to protein folding

## **Unit VII – COMPARATIVE PROTEIN MODELING**

Modelling by Homology-the alignment, construction of frame work ,selecting variable regions, side chain placement and refinement, validation of protein models –Ramchandran plot, threading and ab initio modelling.

**Semester – II**  
**Herbal Chemistry**  
**Core Course – VIII**  
**Bio-Molecules**

**Full Marks:70**

**Credit -5**

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**Unit – 1: Carbohydrate**

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides – Structure determination and chemical synthesis (Sucrose, Lactose, Maltose and Cellobiose). Polysaccharides – Structural (Cellulose and Chitin), Storage (Starch and Glycogen). Structure of glucosaminoglycons, Carbohydrates of glycoproteins and glycolipids.

**Unit – 2: Lipids**

Fatty acids, essential fatty acids, structure and function of triacylglycerols. Glycerophospholipids, lipoproteins, Biological membranes, lipid metabolism-B-oxidation of fatty acids.

**Unit – 3: Amino acids, Peptides and Proteins**

Chemical and enzymatic hydrolysis of proteins, amino acid sequencing, secondary structure of proteins, forces responsible for secondary structure of proteins,  $\alpha$ -helix,  $\beta$ -sheet, super secondary structure, tertiary structure of proteins – folding and domain structure, quaternary structure.

**Unit – 4: Nucleotides and Nucleic acids**

Chemical properties of pyrimidine and purine derivatives, chemical synthesis of purine and pyrimidine derivatives, Purine and Pyrimidine bases in nucleic acids, Base pairing via H-bonding, Structure of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), double helical model of DNA, Chemical and enzymatic hydrolysis of nucleic acids.

**Unit – 5: Terpenoids**

Introduction, classification. Isoprene rule, Structure determination and synthesis of the following compound – Citral,  $\alpha$ -terpineol, linalool and camphor.

**Unit – 6: Alkaloids**

Introduction, classification, general methods of structure determination, structure determination and synthesis of the following compounds – Nicotine, papaverine, atropine.

**Semester – II**  
**Herbal Chemistry**  
**Core Course – IX**  
**Herbal Inorganic Chemistry**

**Full Marks:70**

**Credit -5**

1. Extraction of juice from Herbal Plants and Fruits of Medicinal value and their Qualitative analysis for at least two cations and two anions with special reference to  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cu}^{++}$ ,  $\text{As}^{+++}$ ,  $\text{Fe}^{+++}$  (ic),  $\text{Co}^{++}$ ,  $\text{Mn}^{++}$ ,  $\text{Cr}^{+++}$ ,  $\text{Ag}^+$ ,  $\text{PO}_4^{---}$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{--}$ , etc.
2. Extraction of juice from Root, Stem and Leaves and Fruits of different plants having medicinal value and then
  - i. Estimate the amount of  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  ion. Using E.D.T.A.
  - ii.  $\text{Cu}^{++}$  ion by Iodometric titration.
  - iii.  $\text{Fe}^{+3}$  (ic) ion by dichromate or permagnate titration.
  - iv.  $\text{Ag}^+$  ion by argentometric titration.
  - v. Cr and Zn gravimetrically.
3. Preparation of complex compounds:
  - i. Renick's salt
  - ii. Potassium cobaltinitrite.
  - iii. Potassium trioxalato ferrate.
  - iv. Hexamine Ni (II) chloride.
4. Viva
5. Record



**Semester – III**  
**Herbal Chemistry**  
**Core Course – X**  
**Application of Spectroscopy**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit – 1: Rotational Spectra**

Classification of molecules, rigid rotor model, non-rigid rotators, quantization of rotational energy level, fine structure of rotational spectra, isotope effect, Stark effect, nuclear and electron spin interaction, bond length calculation.

**Unit – 2: Vibrational-rotational spectra**

Schrodinger equation applied to harmonic oscillator, quantization of vibrational energy level, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength, selection rules for IR and Raman spectra., group frequencies, overtones, polyatomic molecules, normal modes of vibration, finger print region, symmetry and shapes of AB<sub>2</sub>, AB<sub>3</sub>, AB<sub>4</sub>, AB<sub>5</sub>, and AB<sub>6</sub>, Anharmonic oscillator.

**Unit – 3 :UV and Visible Spectroscopy** – Various electronic transitions, Beer – Lambert law, effect of solvent on electronic transition, Fieser – Woodward rules for conjugated dienes and carbonyl compound, UV spectra of aromatic and heterocyclic compounds, steric effects in biphenyls.

**IR Spectroscopy** – Characteristic vibrational frequencies of organic functional groups, detailed study of vibrational frequencies of carbonyl compounds, effect of H-bonding and solvent effect on vibrational frequencies.

**Unit -4 :NMR Spectroscopy** – Shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei, chemical exchange, spin – spin interaction, Interpretation of PMR spectra of organic compounds.

**Carbon – 13 NMR Spectra** – General considerations, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons), Coupling constant.

**Unit-5: Mass Spectrometry** – Ion production, factors affecting fragmentation, ion analysis, ion abundance, Mass spectral Fragmentatuioin of organic compounds, common functional groups,

molecular ion peak, metastable peak, Mc Lafferty rearrangement, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

**Unit-6: (a) Electron Spin Resonance Spectroscopy:** Theory, Instrumentation and Important analytical application.

**Electron Spectroscopy:** Theory, Instrumentation and applications of Electron Spectroscopy (ESCA and Auger), Scanning electron microscopy (SEM), Scanning tunneling microscopy (STM) and Atomic force microscopy (AFM).

**(b) Plasma Emission Spectroscopy:** Theory, Instrumentation and Analytical applications of inductively coupled plasma emission spectroscopy (ICPE).

**Semester – III**  
**Herbal Chemistry**  
**Core Course – XI**  
**Herbal drugs and standardization**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit – 1: Quality Parameters and Methods Followed**

Systematic study of Crude Drugs: Origine, common names, scientific nomenclature and family, geographical source and history cultivation, collection, preservation and storage, Macroscopical, Microscopical and sengorty (organoleptic) characters; chemical composition where possible; identity, purity, strength and assay, substitute and adulterants etc.

**Unit – 2: Foreign Matter and Determination of Foreign Matter**

Determination of total Ash Acid insoluble ash, water soluble ash, sulphated ash; Determination of Alcohol Soluble Extractive; water soluble extractive; determination of ether soluble extractive (Fixed oil content), Determination of Moisture content, Determination of volatile oil in Drugs; Estimation of Fatty oils, Alkaloids etc.

**Unit – 3:**

Determination of Powder fineness, Refractive index, weight per milliliter and specific gravity, melting range, boiling range, optical rotation viscosity.

Uniformity of weight (Tablets); Total solids in Asava / Aritha; Determination of saponification value, iodine value, Acid value, Peroxide value, Unsaponifiable metter, Detection of Mineral oil, Rancidity Test Determination of Reichert Meissel and polenski value, Determination of Alcohol Content.

**Unit – 4:**

Limit test for heavy metals, Arsenic, lead, Determination of Heavy metals by atomic absorption spectrophotometer inductively coupled plasma mass spectrometry Quantitative analysis for pesticide residue, Test for Aflatoxins, microbial limit tests and tests for specified micro organisms.

**Books Recommended:** Quality Control Manual for Ayurvedic, Siddha and Urani Medicine by Govt. of India, Department of AYUSH, GHAZIABAD.

**Herbal Chemistry**  
**Core Course – XII**  
**Environmental & green chemistry**

**Full Marks:70**

**Credit -5**

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Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit – 1:** Environment: Introduction, composition of atmosphere, vertical temperature, vertical stability, biogeochemical cycle of C, N, P, S and O, Biodistribution of the elements.

**Unit – 2:** Hydrosphere: Chemical composition of water bodies, Hydrological cycles, Aquatic pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills, water quality parameters – dissolved oxygen, biochemical oxygen demand, solid metals, contents of chlorides, sulphate, phosphate, nitrate and microorganisms, water quality standards. Analytical methods for measuring BOD, DO, COD, F, oils, metals (As, Cd, Cr, Hg, Pb, Se) residual chloride and chlorine demand, Purification and treatment of water.

**Unit – 3:** Soils: Composition, micro and macro nutrients, pollution – fertilizers, pesticides, plastics and metals, waste treatment.

**Unit – 4:** Atmosphere: Chemical composition of atmosphere – particles, ions, radicals and their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S green house effect, acid rain, air pollution – controls and their chemistry. Analytical methods for measuring air pollutants.

**Unit – 5:** Industrial Pollution: Cement, Sugar, Distillery, Drug, paper and pulp, thermal power plants, metallurgy, polymers, Disposal of industrial waste and their management.

**Unit -6: Green Chemistry:** The twelve principles of green chemistry atom economy in chemical synthesis, important techniques employed in green chemistry. Organic waste management. Use of safer reagents and green solvents and green catalysts. Replacement of CFC and hydrocarbon blowing agents with environmental friendly blowing agent CO<sub>2</sub> in the production of polystyrene.

**Books recommended**

Environmental Chemistry – Sharma and Kaur – Krishna Publishers

Environmental Chemistry – AK DE, Wiley Eastern

Environmental Pollution Analysis – SM Khopkar, Wiley Eastern Analytical Chemistry

**Herbal Chemistry**  
**Core Course – XIII**

**Chemistry of medico-botanical plants**

**Full Marks:70**

**Credit -5**

The paper will consist of seven questions divided into three sections.

Group A: Question No. 1 will be compulsory comprising ten objective type questions (two from each Unit) each carrying two marks (10x2=20 marks)

Group B: Question No.2 will be compulsory comprising five short answer type questions (One from each Unit) any four to be answered. (4x5=20)

Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit – 1: Medico – Botanical Science:**

- (a) Introduction to Medicinal Plants (studies of some plants already being used in Aurvedic, Tibbi, Chinese and Homeopath medicine), their occurrence in different areas of the World and ecological studies.
- (b) Morphological studies of medicinal plants.
- (c) Important identifying characters like appearance colour, smell season of flowering etc.
- (d) Useful Parts and their specific characters, properties and uses. Season and method of collection of different parts viz. root, stem, bark leaves, flowers, fruits, seeds and exudates.

**Unit – 2**

Application and theoretical aspects (both modern and traditional) of Herbs and Herbal Extracts in different purposes as.

- (a) Medicines (ii) Dyes (iii) cosmetics (iv) Chemicals (v) Essence / perfumes, (vi) Preservatives (vii) Polymers / Macromolecules (viii) Herbicides (ix) Food Technology (x) Diet and nutrition and (xi) Plant Hormones.

[Students should visit different Botanical / Medicinal Plants Gardens/ Aurvedic medicinal Production Plants in the vicinity of Local areas in the guidance of Teachers.

For the theoretical aspects they should have seminars/ symposium with the experts from different laboratories like CDRI, Lucknow etc. in the supervision of teachers.]

Unit -3: Solvent Extraction (i.e. liquid – liquid extraction) method of separation, Principle, Types of extraction systems, classification, mechanism; Extraction by chelation, Ion pair formation, Selectivity of Extraction, Recovery of extracted substance and extraction technique (e.g. separation of amino acids) and examples of more application to Herbs Applied.

**Core Course – XIV**  
**Practical**  
**Herbs & Chemical Techniques**

Time: 6 Hours

Full Marks: 70

**Credit -5**

1. Identification of Single compounds using TLC and Chemical Tests.
2. Organic Synthesis (One step synthesis)
3. Any of the following experiments:
  - a) Determination of COD & BOD of water sample
  - b) Estimation of amino / Phenolic – OH using Bromate – Bromide solution.
  - c) Determination of iodine or saponification values of oil
4. Note Book
5. Viva – Voce

**Elective Course(H) 1**  
**Instrumental and analytical chemistry**

**Full Marks:70**

**Credit -5**

The paper will consist of seven questions divided into three sections.

Group A: Question No. 1 will be compulsory comprising ten objective type questions (two from each Unit) each carrying two marks (10x2=20 marks)

Group B: Question No.2 will be compulsory comprising five short answer type questions (One from each Unit) any four to be answered. (4x5=20)

Group C: Five long answer type questions are to be set (one from each Unit) of which any three to be answered (3x10=30 marks)

**Unit I:**

Applications and Theoretical aspects of different Instrumental methods of Chromatography: Partition Chromatography, Paper Chromatography, Column Chromatography, High Performance Liquid Chromatography, Thin Layer Chromatography, Gas Chromatography, Ion Exchange Chromatography, Electrophoresis, Exclusion Chromatography, Pyrolysis gas Chromatography, Vapour Phase Chromatography, Affinity Chromatography.

**Unit II:**

Instrumentation and applications of flurometry: Photo Flurometer for the determination of vitamins, quinine, determination of codeine and morphine in a mixture. Flurometric determination of aluminium, cadmium and calcium.

Flame emission instrumentation to be utilized as flame photometer for the determination of alkaloid metal sodium potassium, calcium, magnesium and lithium for routine determination of these elements. Atomic absorption spectrophotometer and its applications for the determination of qualitative and quantitative analysis of metals and trace elements in herbs.

Unit III: (a) **Drug Metabolism**

Pathways for deactivation. Prodrugs. Drug delivery systems. Pharmacogenomics, Nucleic acid as therapeutics, Proteins as therapeutics

(b) Interactions of herbs with cytochrome P 450. Effect of some hypoglycemic herbs on the activity of phase I and II drug metabolizing enzymes in alloxan induced diabetic

**Group – B (Analytical Chemistry)**

**Unit – 1:** Analysis of Water pollution: Origin of waste water, water pollutions and their effects, Sources of water pollution, Parameters for analysis colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, different anions, different forms of nitrogen, Heavy metal pollution.

**Unit – 2: (a)DTA:** Basic Principles, Instrumentation, application, DTG, MDTA

**(b) Colourimetry:** Basic principle, Beer-Lambert law, Photoelectric colorimeter, its application for the estimation of carbohydrates, ascorbic acid and proteins.

**(c) Chromatography:** Classification, Chromatography terminology ( $R_f$  value), Development of Chromatograph



**Herbal Chemistry**  
**Elective Course(H) 2**  
**Herbal Chemistry Lab Course**

Time: 12Hours

Full Marks: 50+50

**Credit -5**

**Herbal Chemistry Lab Course**

1. Extraction of different constituents of Herbs by Solvent Extraction Process (using soxhlets) and separation of atleast one component by chromatography (i) Alkaloid (ii) Terpenes (iii) Steroids (iv) Protein (v) Plant Pigments (vi) Vitamins (vii) Perfume or cosmetic component.
2. Identification and separation of possible constituents of the extracts of Herbs by TLC or paper or coloumn chromatography or GLC etc.
3. Spectrophotometric (UV / VIS) / Electrophoretic methods for the estimations of
  - (i) Amino Acids
  - (ii) Proteins
  - (iii) Carbohydrates
  - (iv) Cholesterol
  - (v) Ascorbic Acid
  - (vi) Aspirin
  - (vii) Caffeine
4. Project work & Field Work  

Each Student will make project on one specific plant after collection of the specimen of medicinal plant.
5. Viva – Voce

**Books recommended**

Principle & Techniques – LG Hargis, Prentice Hall.

Principles of Instrumental analysis – DA Skoog and JL Loary.