Skill Enhancement Courses (SEC)

6. Foundation Course - I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Overview of Indian Society	05
2	Concept of Disparity- 1	10
3	Concept of Disparity-2	10
4	The Indian Constitution	10
5	Significant Aspects of Political Processes	10
	Total	**45**

Sr. No.	Modules / Units
1	**Overview of Indian Society**
	Understand the multi-cultural diversity of Indian society through its demographic composition: population distribution according to religion, caste, and gender; Appreciate the concept of linguistic diversity in relation to the Indian situation; Understand regional variations according to rural, urban and tribal characteristics; Understanding the concept of diversity as difference
2	**Concept of Disparity- 1**
	Understand the concept of disparity as arising out of stratification and inequality; Explore the disparities arising out of gender with special reference to violence against women, female foeticide (declining sex ratio), and portrayal of women in media;Appreciate the inequalities faced by people with disabilities and understand the issues of people with physical and mental disabilities
3	**Concept of Disparity-2**
	Examine inequalities manifested due to the caste system and inter-group conflicts arising thereof; Understand inter-group conflicts arising out of communalism; Examine the causes and effects of conflicts arising out of regionalism and linguistic differences
4	**The Indian Constitution**
	Philosophy of the Constitution as set out in the Preamble; The structure of the Constitution-the Preamble, Main Body and Schedules; Fundamental Duties of the Indian Citizen; tolerance, peace and communal harmony as crucial values in strengthening the social fabric of Indian society; Basic features of the Constitution
5	**Significant Aspects of Political Processes**
	The party system in Indian politics; Local self-government in urban and rural areas; the 73rd and 74th Amendments and their implications for inclusive politics; Role and significance of women in politics

Topics for Project Guidance: Growing Social Problems in India:

- *Substance abuse- impact on youth & challenges for the future*
- *HIV/AIDS- awareness, prevention, treatment and services*
- *Problems of the elderly- causes, implications and response*
- *Issue of child labour- magnitude, causes, effects and response*
- *Child abuse- effects and ways to prevent*
- *Trafficking of women- causes, effects and response*

Note:

Out of the 45 lectures allotted for 5 units for Semester I, about 15 lectures may be allotted for project guidance

Skill Enhancement Courses (SEC)

6. Foundation Course - II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Globalisation and Indian Society	07
2	Human Rights	10
3	Ecology	10
4	Understanding Stress and Conflict	10
5	Managing Stress and Conflict in Contemporary Society	08
	Total	**45**

Sr. No	Modules /Units
1	**Globalisation and Indian Society**
	Understanding the concepts of liberalization, privatization and globalization; Growth of information technology and communication and its impact manifested in everyday life; Impact of globalization on industry: changes in employment and increasing migration; Changes in agrarian sector due to globalization; rise in corporate farming and increase in farmers' suicides.
2	**Human Rights**
	Concept of Human Rights; origin and evolution of the concept; The Universal Declaration of Human Rights; Human Rights constituents with special reference to Fundamental Rights stated in the Constitution
3	**Ecology**
	Importance of Environment Studies in the current developmental context; Understanding concepts of Environment, Ecology and their interconnectedness; Environment as natural capital and connection to quality of human life; Environmental Degradation- causes and impact on human life; Sustainable development- concept and components; poverty and environment
4	**Understanding Stress and Conflict**
	Causes of stress and conflict in individuals and society; Agents of socialization and the role played by them in developing the individual; Significance of values, ethics and prejudices in developing the individual; Stereotyping and prejudice as significant factors in causing conflicts in society. Aggression and violence as the public expression of conflict
5	**Managing Stress and Conflict in Contemporary Society**
	Types of conflicts and use of coping mechanisms for managing individual stress; Maslow's theory of self-actualisation; Different methods of responding to conflicts in society; Conflict-resolution and efforts towards building peace and harmony in society

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Semester I USBO101		**L**	**Cr**
Paper I -- Plant Diversity 1		**45**	**2**
UNIT I		**15**	
ALGAE			
1	Structure, life cycle and systematic position of *Nostoc* and *Spirogyra*.		
2	Economic importance of Algae.		
UNIT II		**15**	
FUNGI			
1	Structure, life cycle and systematic position of *Rhizopus* and *Aspergillus*		
2	Economic importance of Fungi.		
3	Modes of nutrition in Fungi (Saprophytism and Parasitism).		
UNIT III		**15**	
BRYOPHYTA			
1	General characters of Hepaticae		
2	Structure, life cycle and systematic position of *Riccia*.		

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Semester I USBO102		**L**	**Cr**
Paper II – Form and Function 1		**45**	**2**
UNIT I		**15**	
CELL BIOLOGY			
1	General structure of plant cell: cell wall Plasma membrane (bilayer lipid structure, fluid mosaic model)		
2	Ultra structure and functions of the following cell organelles: Endoplasmic reticulum and Chloroplast		
UNIT II		**15**	
ECOLOGY			
1	Energy pyramids, energy flow in an ecosystem.		
2	Types of ecosystems: aquatic and terrestrial.		
UNIT III		**15**	
GENETICS			
1	Phenotype/Genotype, Mendelian Genetics- monohybrid, dihybrid; test cross; back cross ratios.		
2	Epistatic and non epistatic interactions; multiple alleles.		

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	Semester I USBOP1	**L**	**Cr**
	PRACTICAL Paper I – Plant Diversity 1	30	1
1	Study of stages in the life cycle of *Nostoc* from fresh/ preserved material and permanent slides.		
2	Study of stages in the life cycle of *Spirogyra* from fresh/ preserved material and permanent slides.		
3	Economic importance of algae: *Ulva* (Biofuel), *Spirulina* (Neutraceutical), *Gelidium* (Agar)		
4	Study of stages in the life cycle of *Rhizopus* from fresh/ preserved material and permanent slides.		
5	Study of stages in the life cycle of *Aspergillus* from fresh/ preserved material and permanent slides.		
6	Economic importance of Fungi: Mushroom , Yeast, wood rotting fungi (any bracket fungus).		
7	Study of stages in the life cycle of *Riccia* from fresh/ preserved material.		
8	Study of stages in the life cycle of *Riccia* with the help of permanent slides.		
	PRACTICAL PAPER II- FORM AND FUNCTION 1	30	1
1	Examining various stages of mitosis in root tip cells (*Allium)*		
2	**Cell inclusions:** Starch grains (Potato and Rice); Aleurone Layer (Maize)		
3	Cystolith (*Ficus*); Raphides (*Pistia*); Sphaeraphides (*Opuntia*).		
4	Identification of cell organelles with the help of photomicrograph: Plastids: Chloroplast, Amyloplast, Endoplasmic Reticulum and Nucleus		
4	**Identification of plants adapted to different environmental conditions:** Hydrophytes: Floating: Free floating (*Pistia*/*Eichornia*); Rooted floating (*Nymphaea*); Submerged (*Hydrilla*)		
5	Mesophytes (any common plant); Hygrophytes (*Typha*/*Cyperus*)		

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6	Xerophytes : Succulent (*Opuntia*); Woody Xerophyte (*Nerium*); Halophyte (*Avicennia* pneumatophore) No sections in ecology, only identification and description of specimens. Morphological adaptations only.		
7	Calculation of mean, median and mode.		
8	Calculation of standard deviation.		
9	Frequency distribution, graphical representation of data- frequency polygon, histogram, pie chart.		
10	Study of Karyoptypes: Human: Normal male and female, *Allium cepa* .		

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	Semester II USBO201	**Hrs**	**Cr**
	Paper I -- Plant Diversity 1	**45**	**2**
UNIT I		**15**	
PTERIDOPHYTES			
1	Structure life cycle, systematic position and alternation of generations in *Nephrolepis*		
2	Stelar evolution		
UNIT II		**15**	
GYMNOSPERMS			
2	Structure life cycle systematic position and alternation of generations in *Cycas*		
3	Economic importance of Gymnosperms		
Unit III			
ANGIOSPERMS		**15**	
1.	Leaf: simple leaf, types of compound leaves, Incisions of leaf, venation, phyllotaxy, types of stipules, leaf apex, leaf margin, leaf base, leaf shapes. Modifications of leaf: spine, tendril, hooks, phyllode, pitcher, *Drosera* or insectivorous plants.		
2	Inflorescence: Racemose: simple raceme, spike, catkin, spadix, panicle. Cymose: monochasial, dichasial, polychasial. Compound: corymb, umbel, cyathium, capitulum, verticellaster, hypanthodium.		
3	Study of following families: Malvaceae, Amaryllidaceae.		

	Semester II USBO202	**Hrs**	**Cr**
	Paper II – Form and Function 1	**45**	**2**
UNIT I		**15**	
ANATOMY			
1	Simple tissues, complex tissues.		
2	Primary structure of dicot and monocot root, stem and leaf.		
3	Epidermal tissue system: types of hair, monocot and dicot stomata.		

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UNIT II		**15**	
PHYSIOLOGY			
1	Photosynthesis: Light reactions, photolysis of water, photophosphorylation (cyclic and non cyclic), carbon fixation phase (C_3, C_4 and CAM pathways).		
UNIT III		**15**	
MEDICINAL BOTANY			
1	Concept of primary and secondary metabolites, difference between primary and secondary metabolites.		
2	Grandma's pouch: Following plants have to be studies with respect to botanical source, part of the plant used, active constituents present and medicinal uses: *Oscimum sanctum, Adathoda vasica, Zinziber officinale, Curcuma longa, Santalum album, Aloe vera*.		

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	Semester II USBOP2	**Cr**
	PRACTICAL Paper I – Plant Diversity 1	**1**
1	Study of stages in the life cycle of *Nephrolepis* : Mounting of ramentum, hydathode, T.S. of rachis.	
2	T.S. of pinna of *Nephrolepis* passing through sorus.	
3	Stelar evolution with the help of permanent slides: Protostele: haplostele, actinostele, plectostele, mixed protostele, siphonostele: ectophloic, amphiphloic, dictyostele, eustele and atactostele.	
4	*Cycas:* T.S of leaflet (*Cycas* pinna)	
5	Megasporophyll, microsporophyll, coralloid root, microspore, L.S. of ovule of *Cycas* – all specimens to be shown.	
6	Economic importance of Gymnosperms: *Pinus* (turpentine, wood, seeds)	
7	Leaf morphology : as per theory	
8	Types of inflorescence: as per theory	
9	Malvaceae	
10	Amaryllidaceae	
	PRACTICALPaper II – Form and Function 1	**1**
1	Primary structure of dicot and monocot root.	
2	Primary structure of dicot and monocot stem.	
3	Study of dicot and monocot stomata.	
4	Epidermal outgrowths: with the help of mountings Unicellular: *Gossypium*/Radish Multicellular: *Lantana*/Sunflower Glandular: *Drosera* and Stinging: *Urtica* – only identification with the help of permanent slides. Peltate: *Thespesia* Stellate: *Erythrina*/*Sida acuta*/*Solanum/Helecteris*	

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	T-shaped: *Avicennia*	
5	Separation of chlorophyll pigments by strip paper chromatography.	
6	Separation of amino acids by paper chromatography.	
7	Change in colour because of change in pH: Anthocyanin: black grapes/Purple cabbage	
8	Test for tannins: tea powder/catechu.	
9	Identification of plants or plant parts for grandma's pouch as per theory.	

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DISTRIBUTION OF TOPICS AND CREDITS
F Y B Sc. BOTANY SEMESTER I

Course	Nomenclature	Credits	Topics
USBO1O1	PLANT DIVERSITY 1	02	1. Algae
			2. Fungi
			3. Bryophyta
USBO1O2	FORM AND FUNCTION I	02	1. Cell Biology
			2. Ecology
			3. Genetics
USBOP1	Plant Diversity I, form and Function I (Practical I & II)	02	

F Y B Sc BOTANY SEMESTER II

Course	Nomenclature	Credits	Topics
USBO2O1	PLANT DIVERSITY I	02	1. Pteridophytes
			2. Gymnosperms
			3. Angiosperms
USBO2O2	FORM AND FUNCTION I	02	1. Anatomy
			2. Physiology
			3. Medicinal Botany
USBOP2	Plant Diversity I, Form and Function I (Practical I & II)	02	

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References

1. College Botany Volume I and II Gangulee, Das and Dutta latest edition. Central Education enterprises
2. Cryptogamic Botany Volume I and II by G M Smith McGraw Hill.
3. Genetics by Russel. Wesley Longman inc publishers. (5th edition)
4. Plant Physiology by Taiz and Zeiger Sinauer Associates inc. publishers
5. Fundamentals of Ecology by E P Odum and G W Barrett. Thompson Asia Pvt Ltd. Singapore.
6. Cell Biology by De Robertis

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Scheme of Examinations

Internal and External Assessment as per CBSS of University of Mumbai

Note:

- Two short field excursions for habitat studies are compulsory.
  Field work of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.
- A candidate will be allowed to appear for the practical examinations only if he/she submits a certified journal of F.Y.B.Sc. Botany or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of F.Y.B.Sc. Botany as per the minimum requirements. In case of loss of journal a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However such a candidate will be allowed to appear for the practical examination but the marks allotted for the journal will not be granted.

UNIVERSITY OF MUMBAI
No. UG/166 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the B.Sc. degree course , **vide** this office Circular No. UG/128 of 2011, dated 13th June, 2011 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by the Ad-hoc Board of Studies in Chemistry at its meeting held on 7th July, 2016 has been accepted by the Academic Council meeting held on 14th July, 2016 **vide** item No. 4.12 and that in accordance therewith, the revised syllabus as per the Choice Based Credit System for F.Y. B.Sc. programme in Chemistry (Sem. I & II), which are available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
19 November, 2016

To,

The Principals of the affiliated Colleges in Science.

A.C/4.12/14.07.2016

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No. UG/166 -A of 2016 MUMBAI-400 032 19 November, 2016

Copy forwarded with Compliments for information to:-

1) The Co-ordinator, Faculties of Science,
2) The Chairman, Board of Studies in Chemistry,
3) The Professor-cum-Director, Institute of Distance & Open Learning (IDOL)
4) The Director, Board of College and University Development,
5) The Co-Ordinator, University Computerization Centre,
6) The Controller of Examinations.

(Dr.M.A.Khan)
REGISTRAR

PTO..

AC_____

Item No._____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of Course	Chemistry
2	Eligibility for Admission	12th of all recognised Board
3	Passing marks	
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic year	2016-2017

Date: **Signature:**

Name of BOS Chairperson: **Professor A.V.Karnik**

Draft of the proposed syllabus for CBCS

F. Y. B. Sc. Chemistry

For the subject of chemistry there shall be two papers for 45 lectures each comprising of three units of 15 L each.

Semester-I

1. Paper-I / II (General Chemistry) Unit-I will be for Physical Chemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry and
3. Paper- I / II Unit-III will be for Organic Chemistry.

Semester-II

1. Paper-I /II (General Chemistry) Unit-I will be for Physical Chemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry and
3. Paper-I / II Unit-III will be for Organic Chemistry.

Choice Based Credit System F.Y.B.Sc. Chemistry Syllabus

To be implemented from the Academic year 2016-2017

SEMESTER I

Course Code	Unit	Topics	Credits	L / Week
USCH101	I	Chemical Thermodynamics Chemical calculations	2	1
	II	Atomic structure, Periodic Table and periodicity		1
	III	Basics of Organic Chemistry: Classification and Nomenclature of Organic Compounds Bonding and Structure of organic compounds Fundamentals of organic reaction mechanism		1
USCH102	I	Chemical Kinetics Liquid state	2	1
	II	Comparative chemistry of Main Group Elements		1
	III	Stereochemistry I		1
USCHP1		Chemistry Practicals	2	6

SEMESTER II

Course Code	UNIT	Topics	Credits	L /Week
USCH201	I	Gaseous state Chemical Equilibrium and thermodynamic parameters	2	1
	II	Concept of Qualitative Analysis Acid Base Theories		1
	III	Chemistry of Aliphatic Hydrocarbons		1
USCH202	I	Ionic equilibria, Molecular Spectroscopy Solid State Chemistry	2	1
	II	Chemical bond and Reactivity Oxidation Reduction Chemistry		1
	III	Stereochemistry II: Cycloalkanes and Conformational Analysis Aromatic hydrocarbons		1
USCHP2		Chemistry Practicals	2	6

Semester I
Paper I
Unit-I

1.1 Chemical Thermodynamics: (10L)

Thermodynamic terms: System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zeroth law of thermodynamics

First law of thermodynamics: concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected)

Thermochemistry: Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation (Numericals expected)

1.2 Chemical Calculations: (5L)

Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, weight to volume ratio, ppm, ppb, millimoles, milliequivalents (Numericals expected)

Unit II

2.1 Atomic structure: (10L)

(Qualitative treatment only; it is expected that the learner knows the mathematical statements and understands their physical significance after completing this topic. No derivations of the mathematical equations required)

a) Historical perspectives of the atomic structure; Rutherford's Atomic Model, Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Structure of hydrogen atom.
b) Hydrogenic atoms:
    1. Simple principles of quantum mechanics;
    2. Atomic orbitals
        i) Hydrogenic energy levels
        ii) Shells, subshells and orbitals
        iii) Electron spin
        iv) Radial shapes of orbitals
        v) Radial distribution function
        vi) Angular shapes of orbitals.

3. Many Electron Atoms
    i) Penetration and shielding
    ii) Effective nuclear charge
4. Aufbau principle

2.2: Periodic Table and periodicity : (5L)

Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements; Periodicity in the following properties : Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule); electronegativity ; Pauling, Mulliken and Alred Rochow electronegativities (Numerical problems expected, wherever applicable.)

Unit III

3. Basics of Organic Chemistry

3.1 Classification and Nomenclature of Organic Compounds: (5L)

Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues.

3.2 Bonding and Structure of organic compounds: (4L)

Hybridization: $sp^{3,}$ $sp^{2,}$ sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide)
Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules.
Shapes of molecules; Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne)
.

3.3 Fundamentals of organic reaction mechanism: (6L)

Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strengths.
Bond fission: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity;
Types (primary, secondary, tertiary, allyl, benzyl), shape and their relative stability of reactive intermediates: Carbocations, Carbanions and Free radicals.

Introduction to types of organic reactions: Addition, Elimination and Substitution reaction. (With one example of each)

Semester I

Paper II

Unit I

1.1 Chemical Kinetics: (8L)

Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected)

Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected)

1.2 Liquid State: (7L)

Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected)

Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected)

Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer (Numericals expected)

Liquid crystals: Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals

Unit-II

2.0 Comparative chemistry of Main Group Elements: (15L)

Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. Some important compounds- $NaHCO_3$, Na_2CO_3, NaCl, NaOH, CaO, $CaCO_3$; oxides of carbon, oxides and oxyacids of sulphur and nitrogen with respect to environmental aspects.

Unit III

3. Stereochemistry I: (15L)

Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions ;
Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti isomerism E/Z notations with C.I.P rules.
Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, Distereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations.
Conformation analysis of alkanes (ethane, propane and n-butane); Relative stability with energy diagrams.

Semester II

Paper I

Unit-I

1.1 Gaseous State: (8L)

Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected)

Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected)

1.2 Chemical Equilibria and Thermodynamic Parameters: (7L)

Reversible and irreversible reactions, law of mass action, dynamic equilibria, equilibrium constant, (K_c and K_p), relationship between K_c and K_p, Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected)

Statement of second law of thermodynamics, concepts of entropy and free energy, spontaneity and physical significance of free energy, thermodynamic derivation of equilibrium constant (Numericals expected)

Unit II

2.1 Concept of Qualitative Analysis: (7L)

a) Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents).

b) Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.)

2.2 Acid Base Theories: (8L)

Arrhenius, Lowry- Bronsted, Lewis, Solvent – Solute concept of acids and bases, Hard and Soft acids and bases. Applications of HSAB
Applications of acid base chemistry in:

i) Understanding organic reactions like Friedel Craft's (acylation/alkylation) reaction
ii) Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.

Unit III

3. Chemistry of Aliphatic Hydrocarbons

3.1 Carbon-Carbon sigma bonds: (3L)

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

3.2 Carbon-Carbon pi bonds: (12L)

Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition),
Mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction(catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2-and 1, 4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination using N-bromosuccinimide and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Semester II

Paper II

Unit I

1.1 Ionic Equilibria: (7L)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid)

Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected)

1.2 Molecular Spectroscopy: (4L)

Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, flourescence, electronic, vibrational and rotational transitions, Beer-Lambert's law (Numericals expected)

1.3 Solid State Chemistry (4L)

Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane, laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected)

Unit II

2.1: Chemical Bond and Reactivity: (7L)

Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for AB_n type molecules with and without lone pair of electrons, isoelectronic principles, applications and limitations of VSEPR theory.

2.2: Oxidation Reduction Chemistry: (8L)

a) Reduction potentials
b) Redox potentials: half reactions; balancing redox equations.
c) Redox stability in water
    i) Latimer and Frost Diagrams
    ii) pH dependence of redox potentials.
d) Applications of redox chemistry
    i) Extraction of elements: (example: isolation of copper by auto reduction)
    ii) Redox reagents in Volumetric analysis: a) I_2; b) $KMnO_4$
    iii) Titration curves:i) single electron systems (example Ce(IV) against Fe(II)); and ii) Multi electron systems as in KMnO4 against Fe(II))

Unit III

3.1 Stereochemistry-II: Cycloalkanes and Conformational Analysis: (5L)

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy.

3.2Aromatic Hydrocarbons: (10L)

Aromaticity: Hückel's ruleanti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism. , Hammond's postulate, Directing effects of the groups.

Reference Books:

Unit I:

1. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014).
2. Ball D.W., Physical Chemistry, Thomson Press, India (2007).
3. Castellan G.W., Physical Chemistry, 4th Ed., Narosa (2004).
4. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
5. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson (2013).
6. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press (2014).
7. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd.,New Delhi (2004).
8. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
9. Metz C.R., 2000 Solved Problems in Chemistry, Schaum Series (2006).
10. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
11. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).
12. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000).

Unit II:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10^{th} Ed., Oxford University Press, 2014.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7^{th} Ed. Cengage Learning India Edition, 2013.

CHEMISTRY LAB:

Semester I

Unit I: Physical Chemistry

1. To prepare 0.1 N succinic acid and standardize the NaOH of two different concentrations
2. To determine the rate constant for the hydrolysis of ester using HCl as catalyst
3. To determine enthalpy of dissolution of salt (like KNO_3)

Unit II: Inorganic Chemistry

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1. Commercial analysis of (any two)
   a) Mineral acid
   b) Organic acid
   c) Salt of weak acid and strong base.

2. Titration using double indicator: analysis of solution of Na_2CO_3 and $NaHCO_3$.
3. Gravimetric analysis
   a) To determine the percent purity of sample of $BaSO_4$ containing NH_4Cl
   b) To determine the percent purity of ZnO containing $ZnCO_3$.

Unit III: Organic Chemistry

1. Purification of any two organic compounds by recrystallization selecting suitable solvent. (Provide 1g.).
   Learners are expected to report
   a) Solvent for recrystallization.
   b) Mass and the melting points of purified compound.

   Learners should calibrate thermometer before determining melting point.

2. Chromatography (Any one)
   a) Separation of a mixture of two sugars by ascending paper chromatography
   b) Separation of a mixture of o-and p-nitrophenols by thin layer chromatography (TLC)

Semester II
Chemistry Lab

Unit I: Physical Chemistry

1. To determine the rate constant for the saponification reaction between ethyl acetate and NaOH
2. To determine dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pHmetrically.
3. To verify Beer-Lambert's law, using $KMnO_4$ solution by colorimetric method.
4. To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.

Unit II: Inorganic Chemistry

1. **Qualitative analysis: (at least 4 mixtures to be analyzed)**
   Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions.
   Cations (from amongst):
   Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^{+},NH^{4+}
   Anions (From amongst):
   CO_3^{2-}, S^{2-}, SO_3^{2-}, NO_2^{-}, NO_3^{-}, Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, PO_4^{3-}
   (Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)
2. **Redox Titration:** To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration)

Unit III: Organic Chemistry

Characterization of organic compound containing C, H, (O), N, S, X elements.
(minimum 6 compounds)

Reference Books

Unit I: Physical Chemistry

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

Unit II: Inorganic Chemistry

Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

Unit III: Organic Chemistry

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

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Item No. 4.70

UNIVERSITY OF MUMBAI

Syllabus for F.Y.B.Sc.
Program BSc
Course: ZOOLOGY

Semester I and II

(Credit Based Semester and Grading System
with effect from the academic year 2015–2016)

Syllabus Committee Members

Dr. Anil S. Singh	-	Convenor
Dr. Manisha Kulkarni	-	Co-convenor
Dr. Jyotsna Mahale	-	Co-convenor
Dr. Meenakshi Sundaresan	-	Co-convenor
Prof. Lata Sardesai	-	Co-convenor
Prof. P.C. Mathew	-	Co-convenor
Dr. Dilip Kakavipure	-	Co-convenor
Dr. V.M. Patole	-	Co-convenor
Dr. Kantilal H. Nagare	-	Co-convenor
Prof. Shanta Janyani	-	Co-convenor
Dr. S. Rangoonwala	-	Co-convenor
Dr. Minakshi Gurav	-	Member (Teacher)
Dr. Shirley B. Agwuocha	-	Member (Teacher)
Dr. Vishakha Shingala	-	Member (Teacher)
Dr. Gayathri N.	-	Member (Teacher)
Dr. Ansariya Rana	-	Member (Teacher)
Dr. Aditya S. Akerkar	-	Member (Teacher)
Dr. Shashikala Prajapati	-	Member (Teacher)
Dr. R.B. Singh	-	Member (Teacher)
Prof. Nitin Wasnik	-	Member (Teacher)
Prof. Nikhil C. Disoria	-	Member (Teacher)
Ms. Purva S. Prabhu	-	Member (Student)
Ms. Sachi R. Mayekar	-	Member (Student)
Ms. NehaVajandar	-	Member (Student)
Ms. Payal A. Shah	-	Member (Student)
Ms. Anuradha Gaikar	-	Member (Student)
Ms. Sonal S. Prabhulkar	-	Member (Student)

Syllabus for
FYBSc
Course – ZOOLOGY

1. Preamble
2. Pedagogy
3. Syllabus Semester I & II
4. References and Additional Reading
5. Scheme of Examination and Paper Pattern
6. Distribution of periods
7. Model Question bank

Aims

- To nurture interest in the students for the subject of Zoology
- To create awareness of the basic and modern concepts of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the basic nutritional and health aspects of human life.
- To inculcate good laboratory practices in students and to train them about scientific handling of important instruments.

Preamble

While presenting this new syllabus to the teachers and students of Semester I and Semester II (F.Y.B.Sc.) Zoology, I am extremely happy to state that for the first time efforts have been made to seek inputs of all the stake holders to make it more relevant.

In the first meeting of the Board of Studies an apex committee was formed to study syllabi worldwide with a view to include modern modules and plan semesters at UG and PG programs in advance to avoid overlapping and duplication of topics in various courses.

Meeting with the industry at the Indian Merchants' Chamber and with the meritorious alumni helped adding need based components. For the first time students were a part of the syllabus committee and the process became participative when the draft was finalized in an open meeting with all the Zoology teachers after having sought democratic criticism on the proposed syllabus placed on the University website for about one month.

While following the guidelines of UGC, use of animals is excluded from the practicals, substituting the same with audiovisual, ICT and simulation aids and that the syllabus is made more interesting with new, innovative topics. Providing the pedagogy as also indicating objectives and desired outcome of every topic for the teachers, and question bank for the students apart from the question paper pattern became an integral part of the syllabus, therefore.

Care is taken to provide the drafts from time to time and declare the final syllabus well in advance enabling the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The success of this revamped syllabus will depend totally on the enthusiasm of the teachers which is very high all throughout the process and their hands will be strengthened by publishing the University text books for the first time. This curriculum of the Zoologists, for the Zoologists and by the Zoologists developed with the united efforts will take our ever progressive subject to greater heights in the years to come.

- VINAYAK DALVIE, Chairman, BOS in Zoology

Syllabus for
FYBSc.
Course – ZOOLOGY
To be implemented from Academic year 2015-16
SEMESTER - I

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO101	I	Wonders of animal world	2	1
	II	Biodiversity and its conservation		1
	III	Footsteps to follow		1
USZO102	I	Laboratory safety and Units of Measurement	2	1
	II	Animal Biotechnology		1
	III	Instrumentation		1
USZOP1	Practical based on both courses		2	6

SEMESTER - II

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO201	I	Population Ecology	2	1
	II	Ecosystem		1
	III	National park and Sanctuaries		1
USZO202	I	Nutrition and Health	2	1
	II	Public health and Hygiene		1
	III	Common human Diseases		1
USZOP2	Practical based on both courses		2	6

SYLLABUS F.Y.B.Sc. ZOOLOGY

UNIT WISE DISTRIBUTION

Semester I		Semester II	
Course 1	**Course 2**	**Course 3**	**Course 4**
Unit 1 Wonders of animal world	Unit 1 Laboratory Safety and Units of Measurement	Unit 1 Population Ecology	Unit 1 Nutrition and Health
Unit 2 Biodiversity and its Conservation	Unit 2 Animal Biotechnology	Unit 2 Ecosystem	Unit 2 Public Health and Hygiene
Unit 3 Footsteps to follow	Unit 3 Instrumentation	Unit 3 National Parks and Sanctuaries	Unit 3 Common Human Diseases
Practical (USZO P1)	Practical (USZO P1)	Practical (USZO P2)	Practical (USZO P2)

PEDAGOGY

F.Y.B.Sc. Syllabus

First year B.Sc. course is the entry point for the students to undergraduate classes which acts like a guiding force for them to make up their mind in selecting a subject they would wish to pursue their studies in future for carving their career in a particular field.

The syllabus committee in the subject of Zoology for F.Y.B.Sc. Class has designed this syllabus with a view that it is most appropriate time when we transform our traditional closed classroom teaching learning practices to more of field and activity based studies, the correct methodology for the study of Natural Sciences. It is recommended to orient the students about ecosystem, bio-diversity, wildlife conservation and management with the help of models, photographs, movies, documentaries, charts and use of ICT and then take learners to field to have realistic experiences. This will enable them to get true insight about endurance of animal life in relation to human activity inducing sentiment of love, care and protection in the young mind and heart leading to understand importance of co-existence and conservation of bio-diversity. An interaction with the officials of wildlife protection force should be allowed to get basic knowledge about the relevant acts through lectures which for creating awareness about these issues and also to make best use of the knowledge in their own interest as well as for the country. Instrumentation and Animal Biotechnology component would initiate academia- industry interface and should be edified in collaboration with expertise from relevant research institutes and industrial establishments and entrepreneurs by inviting them as guest speakers or through industrial visits, excursions for practical experience about the principle, working and application of the instruments for commercial use. Population ecology need to be explained in the context with census to enlighten pupils about the effect of diversity and dynamism of human population on socio economic status of India. Experts from the field of nutrition and health can be invited to enlighten learners on the topics of nutritional value of food, balanced diet, ill-effects of eating junk food and aerated drinks. Medical professionals, relevant NGO's maybe engaged to educate students regarding myth, precautionary measures, immunization drives of common diseases, ill-effects of self-medication and stress, significance of BMI through series of programmes. During medical emergencies it is of immense importance to provide first aid assistance to the diseased within the golden period i.e. of few minutes. This enhances the possibility to save life, thus it is strongly recommended to form a consortium of colleges to conduct training in rotation of first aid techniques for teachers and students both with the help of organizations like Red Cross Society, Health Department of Civic Bodies, Civil Defence Department and Local Self Government etc.

Dr. Anil S. Singh
Convenor

F.Y.B.Sc. ZOOLOGY

(THEORY)

SEMESTER I

USZO101 (Course 1)
Wonders of Animal World, Biodiversity and its Conservation

Unit 1: Wonders of Animal World (15 L)

Objective: *To take learners through a captivating journey of hoarded wealth of marvellous animal world.*

Desired Outcome*: Curiosity will be ignited in the mind of learners, to know more about the fascinating world of animals which would enhance their interest and love for the subject of Zoology.*

1.1**:** Echolocation in Bats and Cetaceans - Dolphins and Whales

1.2**:** Mechanism of Pearl formation in Mollusca

1.3**:** Bioluminescence in Animals: Noctiluca, Glow worm, Firefly, Angler Fish (Mechanism and use for the animal)

1.4**:** Regeneration in Animals - Earthworm (Annelida) and Lizard (Reptile)

1.5**:** Mimicry in Butterflies and its significance: Great Eggfly and Common Crow, Common Palmfly and Plain Tiger.

1.6**:** Mechanism of Coral formation and types of Coral reefs

1.7**:** Bird migration: Definition, types and factors inducing bird migration

1.8**:** Adaptive features of desert animals: Reptiles (Phrynosoma) and Mammals (Camel)

1.9**:** Breeding and Parental care in:

1.9.1**:** Pisces - Ovo-viviparous (Black Molly/Guppy), Mouth brooders (Tilapia), Brood pouches (Sea horse)

1.9.2**:** Amphibia - Mouth brooders (Darwin's Frog), Egg carriers (Midwife Toad)

1.9.3**:** Mammals - Egg-laying (Duck-billed Platypus), Marsupials (Kangaroo)

1.10**:** Aves: Brood Parasitism (Cuckoo)

Unit 2: Biodiversity and its Conservation (15 L)

Objective*: To orient learners about rich heritage of Biodiversity of India and make them understand significance of its conservation.*

Desired Outcome*: Learners would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation*.

2.1: Introduction to Biodiversity - Definition, Concepts, Scope and Significance

2.2: Levels of Biodiversity - Introduction to Genetic, Species and Ecosystem Biodiversity

2.3: Introduction of Biodiversity Hotspots- (Western Ghats and Indo-Burma Border)

2.4: Values of biodiversity - Direct and Indirect use value

2.5: Threats to Biodiversity - Habitat loss and Man-Wildlife conflict

2.6: Biodiversity conservation and management

2.6.1**:** Conservation strategies: *in situ*, ex-situ, National parks, Sanctuaries and Biosphere reserves.

2.6.2**:** Introduction to International efforts : Convention on Biological Diversity (CBD), International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program - World Conservation Monitoring Centre (UNEP-WCMC)

2.6.3**:** National Biodiversity Action Plan, 2002

2.6.4**:** Introduction to Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species

Unit 3: Footsteps to follow (15 L)

Objective*: To teach learners about innovative and novel work of scientists/philosopher/entrepreneurs in the field of biological sciences.*

Desired Outcome*: Minds of learners would be impulsed to think differently and would be encouraged ipso facto to their original crude ideas from the field of biological sciences.*

3.1**:** Dr. Hargobind Khorana (Genetic code)

3.2**:** Dr. Varghese Kurien (Amul –White revolution)

3.3**:** Dr. Salim Ali (Ornithologist)

3.4**:** Anna Hazare (Water Conservation-Ralegan Siddhi)

3.5**:** Baba Amte (Anandvan)

3.6**:** Kiran Mazumdar Shaw (Biocon)

3.7**:** Gadre Fisheries (Surimi)

3.8 : Rajendra Singh

Two cases preferably of local importance to the college be additionally taught.

USZO102 (Course 2)

INSTRUMENTATION and ANIMAL BIOTECHNOLOGY

Unit 1: Laboratory safety, Units and Measurement (15 L)

Objective: *To make learners aware of risks involved in handling of different hazardous chemicals, sensitive (electrical/electronic) instruments and infectious biological specimens especially during practical sessions in the laboratory and to train them to avoid mishap.*

Desired Outcome*: Learners would work safely in the laboratory and avoid occurrence of accidents (mishaps) which will boost their scholastic performance and economy in use of materials/chemicals during practical sessions.*

1.1: Introduction to good laboratory practices

1.2: **Use of safety symbols**: meaning, types of hazards and precautions

1.3: **Units of measurement**:

1.3.1**:** Calculations and related conversions of each: Metric system- length (meter to micrometer); weight (gram to microgram), Volumetric (Cubic measures)

1.3.2**:** Temperature: Celsius, Fahrenheit, Kelvin

1.3.3**:** Concentrations: Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality.

1.3.4**:** Biostatistics: Introduction and scope, Sampling and its types, Central Tendencies (mean, median, mode) Tabulation, Graphical representations (Histograms, bar diagrams, pie diagrams).

Unit 2: Animal Biotechnology (15 L)

Objective: *To acquaint learners to the modern developments and concepts of Zoology highlighting their applications aiming for the benefit of human being.*
Desired Outcome*: Learners would understand recent advances in the subject and their applications for the betterment of mankind; and that the young minds would be tuned to think out of the box.*

2.1: **Biotechnology**: Scope and achievements of Biotechnology (Fishery, Animal Husbandry, Medical, Industrial)

2.2: **Transgenesis**: Retro viral method, Nuclear transplantation method, DNA microinjection method and Embryonic stem cell method

2.3: Cloning (Dolly)

2.4: Ethical issues of transgenic and cloned animals

2.5: **Applications of Biotechnology**:

2.5.1**:** DNA fingerprinting: Technique in brief and its application in forensic science (Crime Investigation)

2.5.2**:** Recombinant DNA in medicines (recombinant insulin)

2.5.3**:** Gene therapy: Ex-vivo and *In vivo*, Severe Combined Immunodeficiency (SCID), Cystic Fibrosis

2.5.4**:** Green genes: Green Fluorescent Protein (GFP) from Jelly fish- valuable as reporter genes used to detect food poisoning.

Unit 3: Instrumentation (15 L)

Objective: *To provide all learners a complete insight about the structure and train them with operational skills of different instruments required in Zoology.*
Desired Outcome: *Students will be skilled to select and operate suitable instruments for the studies of different components of Zoology of this course and also of higher classes including research.*

3.1: Microscopy

3.1.1**:** Construction, principle and applications of dissecting and compound microscope.

3.2: Colorimetry and Spectroscopy - Principle and applications.

3.3: pH - Sorenson's pH scale, pH meter - principle and applications.

3.3: Centrifuge - Principle and applications (clinical and ultra centrifuges).

3.4: Chromatography - Principle and applications (Partition and Adsorption)

3.5: Electrophoresis - Principle and applications (AGE and PAGE)

SEMESTER I

Practical USZOP1 (Course I)

1. Mounting of foraminiferan shells from sand (any 3)
2. Study of types of Corals - Brain, Organ pipe, Stag Horn, Mushroom coral Study of

3Study of the following;

a. Symbiosis (Termite and Trychonympha, hermit crab and sea anemone)
b. Camouflage (leaf insect, chameleon)
c. Cannibalistic mate-eating animals (Spider and Praying Mantis)
d. Animal architects: Termites, Harvester ant and Baya weaver bird
e. Study of bioluminescent organisms – Noctiluca, glow worm, fire fly, angler fish.

4. Breeding and parental care in Amphibia- *Rhacophorus*, Midwife toad, Darwin's frog, Caecilian.
5. Mounting of scales of fish (placoid, cycloid and ctenoid)
6 a) Study of Adaptive radiation in Reptiles - Turtle, Tortoise, *Phrynosoma*, *Draco*)
   b) Identification and differentiation of venomous and non-venomous snakes (Scales, Fangs, Bite marks, etc.)
7. Study of Types of feathers(contour, filoplume, down), beaks(Nectar feeding , Insect catching, Fruit eating, Scavenging, Filter feeding), claws (perching, wading, swimming, hopping) in birds
8 a. Identification of birds - Coppersmith Barbet, Bulbul, Rose ringed Parakeet, Magpie Robin, two local birds.
   b. Field Report – To be done in a group of ten students (submission of written / typed report preferably along with photographs/ tables/ graphs.

Other Suggested topics for field observation/survey:

- Butterflies/ Fishes/ Migratory birds of local area.
- Variations in Human like Attached vs. Free Earlobes, Blood Groups, Eye colour, etc. using statistical method.

9. Observations of fauna in the field (with reference to theory syllabus).

***Note - The practicals may be conducted by using specimens authorised by the wild such other regulating authorities though it is strongly recommended that the same sh taught by using photographs/audio-visual aids/ simulations / models, etc. as recomme the UGC and as envisaged in the regulations of the relevant monitoring bodies. specimens, however, shall be procured for the purpose of conducting practicals m here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER I

Practical USZOP1 (Course II)

1. Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin itant, oxidizing, compressed gases, aspiration hazards and Biohazardous fectious material.)
   b) Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram.
2. Identification of transgenic fish (Trout and Salmon) / cloned animals (Dolly sheep, cc cat and Snuppy dog) from photograph.
3. Extraction of fruit juice with pectinase from apple/guava/or any other suitable fruit
4. Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/Universal Indicator and confirming the result with pH meter.
   Application of DNA Fingerprinting in criminology (photograph of electrophoretic pattern to be given for interpretation by the students)
5. a) Study of parts of microscope and their functions.
   b) Technique of focussing a permanent slide under 10x and 45x (objectives).
6. a) Dilution of given sample and estimation of OD by using colorimeter.
   b) Calculation of concentration from the given OD using formula.
7. Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/universal indicator/pH indicator from red cabbage and confirming the result with pH meter.
   a) Seperation of amino acids from the mixture by paper chromatography.
8. b) Calculation of Rf value of separated pigments/amino acids from given chromatogram and their identification from standard chart.
9. a) Seperation of pigments by adsorption chromatography using chalk.
   b) Seperation of lipids by TLC,

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

REFERENCES AND ADDITIONAL READING

1. Wonders of the Animal World - University Text Book of Zoology, F.Y.B.Sc. Semester I Course 1. V.V. Dalvie, G.B. Raje, P. Sardesai, N.S. Prabhu, University Press.
2. Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology Volume II- Jordan andVerma , S. Chand and Co.
4. Invertebrate Zoology- T. C. Majupuria , S. Nagin and Co.
5. Chordate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
6. Invertebrate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
7. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition
8. Zoology- S. A. Miller and J. B. Harley, Tata McGraw Hill
9. Modern Textbook of Zoology, Invertebrates, R. L. Kotpal
10. Fundamentals of Ecology- E. P. Odum , Sunders Publication
11. Fundamentals of Ecology- M.C.Dash-2nd edition, Tata McGraw Hill
12. Essentials of Ecology and Environmental Science - S.V.S Rana
13. Biodiversity- S.V.S Rana- Prentice Hall Publications
14. Modern Biology- V. B. Rastogi
15. Biology of Mollusca- D. R. Khanna
16. A Textbook of Zoology, Vol. II- T. Jeffery Parker and William. A. Haswell-Low Price Publications
17. Ecology and Environment- P. D. Sharma, R. K. Rastogi Publications
18. Introduction to Ecology- R. Dajoz
19. Wildlife Laws and its Impact on Tribes- Mona Purohit , Deep and Deep Publications
20. Biodiversity- K.C.Agarwal- Agro Botanica Publications
21. Butterflies of India – Isaac Kehimkar- BNHS Publication

Course II (USZO102)

REFERENCES AND ADDITIONAL READINGS

1. Basic Laboratory Techniques, Instrumentation and Biotechnology- University Text Book of Zoology, F.Y.B.Sc. Semester I Course 2. V.V. Dalvie, R. G. Deshmukh, R. D'souza and H.U. Shingadia University Press.

2. Introduction to Practical Biochemistry – David T. Plummer (Tata McGraw Hill Publishing Co. Ltd.)
3. Introductory Practical Biochemistry – S.K. Sawhney and Randhir Singh (Narosa Publishing House)
4. Methods in Biostatistics – B. K. Mahajan, (Jaypee Publications)
5. Microscopy and Cell Biology - V. K. Sharma, (Tata McGraw Hill Publishing Co. Ltd.)
6. Bioinstrumentation – L. Veerakumari, (M.J.P. Publishers)
7. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker, (Cambridge University Press)
8. Biotechnology- Thieman and Pallidino, Pearson edu.
9. Biotechnology –Glick and Pasternak
10. Biochemistry –Satyanarayana
11. Understanding biotechnology- Aluizio Borem ,David Bowe-Low price edition –Pearson Publication
12. A Textbook of Biotechnology – R. C. Dubey, S. Chand Publication.
13. A Manual of Medical Laboratory Technology -A. H. Patel, Navneet Prakashan Ltd.
14. Biological instruments and methodology – Dr. P. K. Bajpai, S. Chand company Ltd.
15. Calculations in Molecular biology and Biotechnology - Frank H. Stephenson, Academic Press.

SCHEME OF EXAMINATION (THEORY)

(a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.

(b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory

Figures to the right indicate full marks

Time: 2.5 hours **Total marks: 75**

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	a. Unit 1 - (One note of five marks OR objective type questions) b. Unit 2 - (One note of five marks OR objective type questions) c. Unit 3- (One note of five marks OR objective type questions)	15 marks

*For Question 4 it is recommended to have objective questions such as –

(a) Match the column (b) MCQ

(c) Give one word for (d) True and False

(e) Define the term (f) Answer in one sentence etc.

MODEL QUESTION BANK SEMESTER I

USZO101(COURSE I)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1 - (05 Marks)

1. Write a note on echolocation in Dolphins/ Whales
2. Write a short note on : Pearl formation in Mollusca
3. Describe : Mechanism of bioluminescence
4. Enumerate the uses of bioluminescence
5. Describe the uses of bioluminescence for…… (Noctiluca, Glow worm, Firefly, Angler fish, etc.)
6. Write a short note on : Luciferin – Luciferase interaction
7. Describe the process of regeneration in Earthworm
8. What is regeneration? Explain the term with an example
9. What is mimicry? Explain with an example.
10. Describe: mimicry in butterfly
11. Describe briefly the formation of Corals
12. Write a short note on types of coral reefs.
13. Describe needs of migration in birds.
14. Describe briefly, the factors inducing migration in birds.
15. How does Camel adapt itself to the desert environment?
16. Describe parental care and breeding in ……. (Examples of Pisces, Amphibia)
17. Describe briefly: Brood parasite
18. Explain parental care in Duck-billed Platypus

UNIT 2 - (05 Marks/10 Marks)

Questions that could be asked for 10 marks:

1. Explain biodiversity and its importance. What is a biodiversity hotspot? Explain Western Ghats as biodiversity hotspot in India.
2. Explain: Direct use value / Indirect use value
3. Explain biodiversity and its types.
4. Enumerate and explain threats to biodiversity.
5. State the factors which amount to habitat loss.
6. Explain the concept of Man-Wildlife conflict with an example.
7. Give a detailed account on *in situ* hybridization and ex-situ hybridization

8. Describe National Park and state its importance in conservation
9. Describe Sanctuary and state its importance in conservation
10. Give a brief account on biosphere reserve.
11. Give a detailed account on: CBD (Convention on Biological Diversity).
12. Give an account of national biodiversity plan 2002.
13. Describe important clauses of Convention for International Trade of endangered species.

Questions that could be asked for 05 marks:

1. Explain biodiversity and mention its types.
2. Explain biodiversity and give two importance
3. Explain biodiversity hotspot
4. Describe *in situ* conservation strategies.
5. Write note on ex-situ conservation strategies.
6. Give an account of genetic / species / ecosystem biodiversity.
7. Enumerate importance threat to biodiversity.
8. State direct and indirect use value of biodiversity.

UNIT 3 - (10 Marks)

1. Give a detailed account on: …….(Name of the eminent personality) For e.g.: Gadre Fisheries, Kiran Mazumdar Shaw, Baba Amte etc.
2. Describe in detail - ……(Name of the case study)
   For e.g.: Amul white revolution, Biocon, Genetic code etc.
3. Give a detailed account on the contribution made by Dr.Salim Ali in the field of Ornithology.
4. What is white revolution? State contribution of Dr. Verghese Kurian for it.
5. Describe the work of water conservation of Anna Hazare.

MODEL QUESTION BANK SEMESTER I USZO102 (COURSE II)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT I: (5 marks)

1. Describe in brief (Minimum five points)
   a. Good laboratory practices
   b. Chemical hazards in a laboratory
   c. Physical hazards in a laboratory
   d. Biological hazards in a laboratory
   e. Personal hygiene in laboratory
   f. Waste disposal
2. Define and give conversions of the three scales of measuring temperature.
3. Define Molarity. How would you prepare
   a. 1 litre of 0.1 M NaOH solution? (Mol.wt. of NaOH=40)
   b. 100 ml of 1M NaOH
   c. 500 ml of 0.2 M NaOH
4. Define Normality. How would you prepare 1 litre of 2 N NaOH solution?
5. Explain briefly the measures of central tendencies?
6. Define mean, median and mode and explain each with an example.
7. The observations of length (in cm) of 10 fishes are 22, 24, 34, 26, 28, 31, 20, 25, 36, 32. Calculate the arithmetic mean of fish length (in cm).
8. Calculate the arithmetic mean for the following data on fish length by Direct method.

Class interval (length in cm)	5-15	15-25	25-35	35-45	45-55
Frequency (no. of fish)	9	21	40	22	8

9. Calculate the arithmetic mean for the above data on fish length by shortcut method.
10. How do you find the median of the data and state the significance of median?
11. What is mode? How do you calculate mode for ungrouped and grouped data?
12. What is random sampling? State the significance.
13. Explain simple, subdivided and multiple bar diagrams.
14. What is a pie diagram? Write the formula for calculating the angles of degrees for different components.
15. The following data shows the areas in million square miles of the oceans of the world. Construct a pie diagram for the data.

16. What is a histogram/Bar diagram? Explain how it is constructed.

Ocean	Pacific	Atlantic	Indian	Antarctic	Arctic	Total
Area (million sq. miles)	70.8	41.2	28.5	7.6	4.8	152.9

UNIT 2: (5 marks)

1. Give applications of Biotechnology in the field of Medicine / Fishery / Animal Husbandry.
2. Give the Scope of Biotechnology in different areas as a diagrammatic sketch
3. What is SCID? Name the scientist who discovered the gene therapy for it.
4. In SCID which enzyme does not work properly?
5. Which cells are used for SCID gene therapy?
6. Which gene is defective in SCID?
7. Define transgenesis and mention any two transgenic animals.
8. Ethical issues of transgenesis.
9. Enlist five applications of DNA finger printing.
10. What are green genes? State one application of it.

(10 marks)

1. Describe SCID and its treatment with suitable diagram.
2. Explain various methods of transgenesis.
3. What is Cystic fibrosis? Explain its diagnostic biotechnological method.
4. Define transgenesis and explain retro viral method with its application.

UNIT 3: (10 marks)

1. Describe the components of a compound microscope giving function.

2. Explain the principle and the applications of compound microscope.
3. Discuss in detail the principle, construction and applications of dissecting microscope.
4. Write the principle and applications of
    a. Colorimeter
    b. Centrifuge
    c. Spectroscopy
    d. Compound microscope
    e. Dissecting microscope
5. Explain the principle of centrifugation and add a note on its application.
6. What is pH? Give the principle and applications of pH meter.
7. Describe paper chromatography as a separation technique.
8. Describe Agarose gel electrophoresis. Add a note on its applications.
9. Explain the principle and applications of Polyacrylamide gel electrophoresis.
10. With the help of a diagram, explain the parts of a colorimeter. Discuss the principle and uses.
11. Describe principle and uses of colorimeter.
12. Explain the principle and application of adsorption chromatography.

PRACTICALS

USZOP1 (Course I)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. From the given sample mount foraminiferan shells (Minimum three types) (15 Marks)

OR

Mounting of scales (placoid and cycloid/ctenoid) from fishes.

Q.2. Identify the photograph of the given animals and comment on the type of interaction /speciality. (symbiosis, camouflage, cannibalistic mate eating animals and animal architects,bioluminiscence). Any two (10 Marks)

Q.3. Identify giving reasons - Venomous/Non-venomous snake (from photographs). (5 Marks)

Q.4. Identification (one specimen each) (10 Marks)

a. Types of corals

b. Amphibians-breeding and parental care

c. Adaptive radiation in reptiles

d. Types of feathers/ claws in birds

e. Types of beaks in birds

Q.5. Field study report (Biodiversity) and viva on it. (10 Marks)

Semester I

USZOP1 (Course II)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q. 1 Dilute the given sample and estimate the OD using colorimeter (Three dilutions) (15marks)

OR

Calculate concentration from given OD by formula (3 concentrations)

OR

Find pH of water samples (three) and comment on their chemical nature.

OR

Using red cabbage pH indicator, determine pH of the given samples and comment on their chemical nature

OR

Extract fruit juice using pectinase and compare the result with a set without using pectinase.

Q. 2. Perform experiment for separation of pigments by adsorption chromatography. (10Marks)

OR

Perform experiment for separation of mixture of amino acids by paper chromatography

OR

Calculate R_f value and identify the pigment from chromatogram.

OR

Perform Thin Layer Chromatography (TLC) for separation of lipids

Q. 3. Focus the given slide under 10 X and 45 X and show it to examiner. (5 Marks)

OR

Prepare a frequency distribution table / Plot histogram / Pie diagram / Bar diagram from the given data.

Q. 4. Identification (10 Marks)
(Safety Symbols (two), parts of compound microscope, transgenic animals, DNA fingerprinting)

Q. 5. Journal and Viva voce(on practical component) (10 Marks)

SEMESTER-II

USZO201 (Course: 3)

Ecology and Wildlife Management

Unit 1: Population ecology: (15 L)

Objective: *To facilitate the learning of population ecology, its dynamics and regulatory factors important for its sustenance.*

Desired Outcome: *This unit would allow learners to study about nature of animal population, specific factors affecting its growth and its impact on the population of other life form.*

1.1: Population dynamics

1.1.1: Population density
1.1.2: Natality
1.1.3: Mortality
1.1.4: Fecundity
1.1.5: Age structure
1.1.6: Sex ratio
1.1.7: Life tables
1.1.8: Survivorship curves
1.1.9: Population dispersal and distribution patterns
1.1.10 Niche concept

1.2: Population growth regulation

1.2.1: Intrinsic mechanism – Density dependent fluctuations and oscillations
1.2.2: Extrinsic mechanism- Density independent, environmental and climate factors, population interactions

1.3: Population growth pattern

1.3.1: Sigmoid
1.3.2: J Shaped

1.4: Human census (India) – Concept, mechanism and significance

Unit 2: Ecosystem: (15 L)

Objective: *To impart knowledge of different components of ecosystem and educate about essentials of coexistence of human beings with all other living organisms.*

Desired Outcome: *Learners will grasp the concept of interdependence and interaction of physical, chemical and biological factors in the environment and will lead to better understanding about implications of loss of fauna specifically on human being, erupting spur of desire for conservation of all flora and fauna.*

2.1: Concept of Ecosystems

2.1.1**:** Ecosystem - Definition and components
2.1.2**:** Impact of temperature on biota
2.1.3**:** Biogeochemical cycles (Water, Oxygen, Nitrogen, Sulphur)
2.1.4**:** Fresh water ecosystem – Lentic and Lotic
2.1.5**:** Food chain and food web in ecosystem (Fresh water and Grass land).
2.1.6**:** Ecological pyramids - energy, biomass and number.
2.1.7**:** Animal interactions (commensalism, mutualism, predation, antibiosis, parasitism)

Unit 3: National parks and Sanctuaries of India (15 L)

Objective: *To enlighten learners about the current status of wild life conservation in India in the light of guidelines from different relevant governing agencies vis-à-vis with adversity of poaching and biopiracy.*
Desired Outcome: *Learners would be inspired to choose career options in the field of wild life conservation, research, photography and ecotourism*.

3.1: Concept of Endangered and Critically Endangered species using examples of Indian Wildlife with respect to National Parks and Wildlife

Sanctuaries of India (Sanjay Gandhi National Park, Tadoba Tiger Reserve, Corbett National Park, Kaziranga National Park, Gir National Park, Silent Valley, Pirotan Island Marine Park, Keoladeo Ghana National Park, Bandipur Sanctuary)

3.2: Management strategies with special reference to Tiger and Rhinoceros in India

3.3: Ecotourism

3.4: Biopiracy

SEMESTER-II

Course: 4 [USZO 202]

NUTRITION, PUBLIC HEALTH AND HYGIENE

Unit 1: Nutrition and Health **(15 L)**

Objective: *To make learners understand the importance of balanced diet and essential nutrients of food at different stages of life.*

Desired Outcome: *Healthy dietary habits would be inculcated in the life style of learners in order to prevent risk of developing health hazards in younger generation due to faulty eating habits.*

1.1**:** Concept of balanced diet, dietary recommendations to a normal adult, infant, pregnant woman and aged.

1.2**:** Malnutrition disorders – Anemia (B_{12} and Iron deficiency), Rickets, Marasmus, Goiter, Kwashiorkar (cause, symptoms, precaution and remedy).

1.3**:** Constipation, piles, starvation, acidity, flatulence, peptic ulcers (cause, symptoms, precaution and remedy).

1.4**:** Obesity (Definition and consequences).

1.5**:** Importance of fibres in food.

1.6**:** Significance of breast feeding.

1.7**:** Swine flu (cause, symptoms, precaution and remedy).

1.8**:** BMI calculation and its significance.

Unit 2: Public Health and Hygiene (15 L)

Objective: *To impart knowledge about source, quantum and need for conservation of fast depleting water resource and essentials of maintaining proper sanitation, hygiene and optimizing use of electronic gadgets.*

Desired Outcome: *Promoting optimum conservation of water, encouragement for maintaining adequate personal hygiene, optimum use of electronic gadgets, avoiding addiction, thus facilitating achievement of the goal of healthy young India in true sense.*

2.1: Health

2.1.1**:** Definition of Health, the need for health education and health goal.

2.1.2**:** Physical, psychological and Social health issues.

2.1.3**:** WHO and its programmes - Polio, Small pox, Malaria and Leprosy (concept, brief accounts and outcome with respect to India).

2.1.4: Ill effects of self-medication.

2.2: Water and water supply

2.2.1**:** Sources and properties of water.

2.2.2**:** Purification of water, small scale, medium scale and large scale (rapid sand filters)

2.2.3 **:** Water footprint (concept, brief accounts and significance).

2.3: Hygiene:

2.3.1**:** Hygiene and health factors at home, personal hygiene, oral hygiene and sex hygiene.

2.4: Radiation risk:

2.4.1**:** Mobile Cell tower and electronic gadgets (data of recommended level, effects and precaution).

2.5: **Blood bank** – Concept and significance

UNIT 3: Common Human Diseases and Disorders (15 L)

Objective: *To educate learners about causes, symptoms and impact of stress related disorders and infectious diseases.*

Desired Outcome: *Learners will be able to promptly recognize stress related problems at initial stages and would be able to adopt relevant solutions which would lead to psychologically strong mind set promoting positive attitude important for academics and would be able to acquire knowledge of cause, symptoms and precautions of infectious diseases*.

3.1: Stress related disorders

3.1.1**:** Hypertension, Diabetes type II, anxiety, insomnia, migraine, depression (cause, symptoms, precaution and remedy)

3.2: Communicable and non-communicable diseases

3.2.1**:** Tuberculosis , Typhoid and Dengue

3.2.2**:** Hepatitis (A and B), AIDS, Gonorrhea and Syphilis

3.2.3**:** Diseases of respiratory system- Asthma, Bronchitis.

3.2.4: Oral Cancer

(Discuss cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy)

SEMESTER II

Practical USZOP2 (Course III)

1. Interpretation of the given graphs/ tables and comment on pattern of population nature :
   i. Survivorship curve
   ii. Life tables
   iii. Fecundity tables
   iv. Age structure
   v. Sex ratio

2. a) Calculation of Natality, Mortality, Population density from given data
   b) Estimation of population density by capture recapture method

3. Interpretation of Growth curves (Sigmoid and J shaped)

4. Estimation of hardness from given water sample (tap water v/s well water)

5. Estimation of Free carbon dioxide (Free CO_2) from two different samples- aerated drinks(diluted) v/s tap water

6. Identification and interpretation of aquatic and terrestrial (Grassland) food chains and food webs

7. Construction of food chain/food web using given information/data.

8. a) Identification and interpretation of ecological pyramids of energy, biomass and number
   b) Construction of different types of pyramid from given data.

9. Study of the following:
   a) Endangered (Great Indian Bustard, Asiatic lion, Blackbuck, Olive Ridley sea turtle) and critically endangered species (Slender-billed vulture, Gharial, Malabar civet) of Indian wildlife and state reasons for their decline
   b) Study Biodiversity hotspots using world map (Western Ghats and Indo-Burma)
   Study of sanctuaries, national parks, biosphere reserves in India with respect to its brand fauna as listed in theory)

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER II

Practical USZOP2 (Course IV)

1. Qualitative estimation of Vitamin C by Iodometric method.

2. Study of microscopic structure of starch granules of different cereals (wheat, maize and jowar).

3. a) Estimation of maltose from brown/white bread.
   b) Moisture content from biscuits or other suitable food products.

4. Food adulteration Test:
   a) Milk adulterants (starch and glucose), methylene blue reduction Test (MBRT).
   b) Adulterants in Cheese, Butter, Jaggery, Ghee, Honey, Iodised Salt.

5. a) Estimation of protein content of two egg varieties.
   b) Study of efficacy of different antacids (any two antacids).

6. .Study of Human Parasites

   Endoparasites - Protozoans (*Entamoeba, Plasmodium*),
   Helminths (*Ascaris, Wuchereria*),
   Ectoparasites (Head louse, tick) and Exoparasites (Bed bug, Mosquito).

7. Screening of anaemic/non-anaemic persons using $CuSO_4$ method.

8. First Aid – Demonstration Practical Training for teachers and students to be conducted by the experts from Redcorss, Civil defence, Civic authorities by individual institute or cluster colleges in rotation.

9. BMI analysis - Measurement of Height/ Weight and calculation of BMI using formula, preparation and submission of report. (10 students/ group-50 readings/group)

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

Semester II USZOP2 (Course III)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. Estimate Hardness from given water samples and compare the results. (15 Marks)

OR

Estimate Free CO_2 from given samples and compare the results.

Q.2. Solve the given problems (using statistical approach wherever possible) based on (Any two) (10Marks)

Natality
Mortality
Sex Ratio
Fecundity
Population density

Q.3. Identify brand animals (Min. 4) and place them in their respective National parks/ Sanctuaries on the given map quoting reasons for their decline. (5 Marks)

OR

Mark National parks and Sanctuaries on the map of India and mention the name of their brand animals stating reason for their decline. (Min. 4)

(5 Marks)

OR

Identify endangered and critically endangered animals (photographs) one each and state their reason of decline (5 Marks)

Q.4. Study the given information and give answers on the basis of food chain/food web and ecological pyramids. (10 Marks)

OR

Prepare food chain/food web and ecological pyramid from the given data and give its significance. (10 Marks)

OR

Identify and interpret the given graph/growth curve/age structure and comment on the pattern of population dispersal. (10 Marks)

OR

Determine Population density by capture and recapture method. (10 Marks)

Q.5. Journal and Viva voce (Based on practical component) (10 Marks)

Semester II USZOP2 (Course IV)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. Estimate Vitamin C from given sample. (15 Marks)

OR

Estimate Maltose content from bread.

OR

Estimate protein content from two different types of eggs.

Q.2. Analyse the given food sample and identify food adulterants (any 2 samples). (10 Marks)

OR

Evaluate milk quality by Methylene Blue Reduction Test (MBRT).

OR

Determine efficacy of different antacids (any two) on acidic solution.

Q.3. Determine moisture content from biscuits/ any other suitable food product. (5 Marks)

OR

On the basis of microscopic structure of starch granules identify different cereals (any two).

OR

Detect adulterants present in th given milk sample (any two).

OR

Determine whether given blood sample is from anaemic/non-anaemic person using $CuSO_4$ Method and suggest the appropriate diet.

Q.4. Identification (10 Marks)

a) One specimen of Protozoan Parasites.

b) One specimen of Helminth Parasites.

c) One specimen from Ectoparasite

d) One specimen from Exoparasite

e) One specimen from Endoparasite

Q.5. Submission of report of Body Mass Index (viva based on it) (10 Marks)

Note: There shall be at least one excursion/field trip.

CourseUSZO201III (Course(USZO201)III)

REFERENCES AND ADDITIONAL READING

1. Introduction to Ecology and Wildlife - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 3. University Press.
2. Fundamentals of Ecology - Eugene P. Odum and Grey W. Barrett, Brook Cole/ Cengage learning
3. Fundamentals of Ecology - M. C. Dash , Tata McGraw Hill company Ltd, New Delhi
4. Ecology - Mohan P. Arora , Himalaya Publishing House
5. Field Biology and Ecology -- Alen H. Benton and William E. Werner ,Tata McGraw Hill ltd, New Delhi
6. Ecology and Environment - Sharma P. D , Rastogi Publication, Mumbai
7. Ecology : Principles and Applications - Chapman J.L , Cambridge University trust
8. Ecology - Subramaniam and Others, Narosa Publishing House
9. Wildlife laws and its impact on tribes - Mona Purohit, Deep and deep Publication
10. Biology - Eldra Solomon, Linda R. Berg and Diana W. Martin, Thomson/ Brooks/ Cole
11. Economic Zoology, Biostats and Animal Behaviour - Shukla, Mathur, Upadhyay, Prasad. Rastogi Publications.

USZO202 (Course IV)

REFERENCES AND ADDITIONAL READING

1. Common Diseases, Health and Hygiene - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 4. University Press.
2. Common Medical Symptoms edited - P. J. Mehta National Inblisents and Distributions
3. Parks Textbook of Preventive and Social Medicine K. Park M/S Banarasidas Bhanot Jabalpar.
4. Human Physiology – Volume I – II C. C. Chatterjee, Medical Allied agency, Kolkatta.
5. Parasitology (Protozoology and Helminthoology) - K. D. Chatterjee, Chatterjee Medial Publishers.

6. Nand's handbook of Forensic Medicine and Toxicology - Apurba Nandy, NCBA publication.
7. Essentials of Public Health and Sanitation- Part I and Part II. All India Institute of Local Self Government.
8. Epidemiology and Management for Health Care for all. P.V. Sathe, A. P. Sathe, Popular Prakashan, Mumbai.
9. Textbook of Medical Parasitology- C. K. JayaramPaniker. Jaypee Brothers.
10. A Treatise on Hygiene and Public Health. -B. N. Ghosh. Calcutta Scientific Publishing Company.
11. Prevention of Food Adulteration, Act 1954. Asian Law House.
12. Clinical Dietetics and Nutrition - F. P. Antia and Philip, Oxford University Press.
13. A Complete Handbook of Nature Cure - Dr. H. K. Bakru, Jaico Publishing House.
14. Dietetics - B. Srilakshmi, New Age International (P) Ltd. Publishers.
15. Nutrition: Principles and Application in Health Promotion - J. B. Lippincott Company. Philadelphia.
16. Are You Healing Yourself Mr. Executive - Dr. R. H. Dastur. IBH Publishing Company.
17. Food Nutrition and Health- Dr. Shashi Goyal, Pooja Gupta, S. Chand Publications.
18. Public Health Nutrition. Edited - Michael J. Gidney, Barrie M. Margetts, John M. Kearney and Lenore Arab. Willey Blackwell Publication.
19. Food and Nutrition – Vol. I and II - Dr. Swaminathan , Bappco Publication.
20. Textbook of Human Nutrition - Mahtab Bamji, Prahlad Rao.
21. Total Health by Paramjit Rana.

SCHEME OF EXAMINATION THEORY

(a) Internal assessment of twenty five (25) marks per course per semester should be conducted as class test according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.

(b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory

Figures to the right indicate full marks

Time: 2.5 hours **Total marks: 75**

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	a. Unit 1 - (One note of five marks OR objective type questions) b. Unit 2 - (One note of five marks OR objective type questions) c. Unit 3- (One note of five marks OR objective type questions)	15 marks

*For Question 4 it is recommended to have objective questions such as –

(a) Match the column (b) MCQ

(c) Give one word for (d) True and False

(e) Define the term (f) Answer in one sentence etc.

MODEL QUESTION BANK

SEMESTER II

USZO203 (COURSE III)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1: (10 marks)

Describe with suitable Example

1. J-Shaped and Sigmoid growth patterns
2. Population dispersal and distribution patterns
3. Natality and Mortality
4. Natality and Fecundity
5. Fecundity and Mortality
6. Density dependant fluctuation and oscillations
7. Population interactions
8. Age structure and population density
9. Concept of niche and its significance in population ecology.

Write notes on / Give a brief account of: (5 marks)

1. Population density
2. Natality
3. Mortality
4. Fecundity
5. Age structure
6. Sex ratio
7. Survivorship curve
8. Sigmoid growth pattern
9. J-shaped growth curve
10. Intrinsic mechanism
11. Extrinsic mechanism
12. Niche
13. Population dispersal and distribution pattern

UNIT 2: (5 marks)

1. Effect of temperature on metabolism

16. Impact of temperature on reproduction
17. Effect of temperature on animal behaviour
18. Define ecosystem and describe any two abiotic factors
19. Define ecosystem and describe any two biotic factors
20. Explain producers / autotrophs
21. Give a brief account of various levels of consumers in an ecosystem
22. Describe in short the inter-relationship between biotic and abiotic factors
23. Describe the following (any one of the cycles can be asked) water cycle, nitrogen cycle and oxygen cycle, sulphur cycle.
24. Explain any one of the following - lake or river
25. Explain food chain from terrestrial or aquatic ecosystem
26. What is food web and explain the same with a suitable example
27. Give a brief account of: Energy pyramid, Pyramid of biomass, Pyramid of numbers.

Unit 3: (10 marks question)

1. State the differences between National park and Wildlife Sanctuary?
2. Write an account of critically endangered species of Indian wildlife with at least two examples.
3. Explain briefly management strategy of any one tiger project in India.
4. Briefly explain management strategy of Rhinoceros project in India.
5. Write in detail about Indian Wildlife (Protection) Act 1972.
6. What is biopiracy? Explain with suitable examples.
7. Write a note on flora and fauna of Sanjay Gandhi national park.
8. Write an account of Tadoba tiger reserve project.
9. Give an account of biodiversity of Jim Corbett national park.
10. Write a note on Ranthambore Tiger reserve.
11. Write in details about Gir Lion project.
12. Write a note on Keoladeo Ghana National park.
13. Write an account of biodiversity of Silent valley.
14. Describe in detail about Bandipur sanctuary.
15. Write a note on ecotourism in India with few examples.

MODEL QUESTION BANK (COURSE IV) SEMESTERII

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

Unit I (5 marks)

Explain the following:

1. Concept of balanced diet and dietary recommendations of any one of the following:
   a) Normal adult b)Infant c) Pregnant woman d) Aged
2. Cause and symptoms of the following: a) Anemia b) B_{12} deficiency c) Vitamin D deficiency d) Marasmus e) Kwashiorkar f) Goiter, g) Swine flu, h) Dengue
3. Precautions and remedy for all above mentioned health conditions.
4. Significance of breast feeding.
5. Importance of fibres in food.
6. Food adulterants and toxins with two side effects of each.
7. Causes, symptoms, precautions and treatment of a) Constipation, b) Piles, c) Insomnia, d) Starvation, e) Flatulence, f) Peptic ulcer, g) Obesity
8. BMI and its significance.

Unit II (5/10 marks)

Question of 5 marks:

1. Give a brief account and outcome of WHO Programs:
   a) Polio b) Smallpox c) Malaria d) Leprosy
2. a) Explain the concept of health goal and health knowledge.
   b) Enlist different needs of health education.
   c) State five points of social health issues.

Question of 10 marks:

1. Describe sources and properties of water in relation to human consumption.

2. Describe methods of purification of water – small scale, medium scale and large scale.
3. Explain the concept of water footprint and give its significance.
4. Describe disposal of human and animal waste – STP and ETP, its functioning and significance.
5. Give a brief of risk of radiation from mobile cell towers and electronic gadgets.
6. Explain the concepts of physical health, psychological health and myth related to it.
7. Describe the term hygiene and explain in brief health factors related to it at home.
8. Explain personal hygiene, oral hygiene and sex hygiene with significance of each.
9. Describe ill effects of self medication with respect to antibiotics and steroids.
10. Give brief account of first aid symbols.

Unit III (10 marks)

1. Explain causes, symptoms, precautions and remedy
   a) Hypertension b) Diabetes Type II c) Anxiety and Insomnia d) Migraine and depression
2. Explain causes, symptoms, precautions and remedy
   a) Tuberculosis b) Common flu c) Dengue d) Malaria e) Typhoid f) Hepatitis A g) Hepatitis B h) AIDS

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AC_____
Item No. _____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Foundation Course (SYBA, SYBSc, SYBCom; Semesters III and IV)**
2	Eligibility for Admission	Not Applicable
3	Passing Marks	**40 %**
4	Ordinances / Regulations (if any)	Not Applicable
5	No. of Years / Semesters	**III and IV Semesters**
6	Level	~~P.G. /~~ **U.G.**~~/ Diploma / Certificate~~ **(Strike out which is not applicable)**
7	Pattern	~~Yearly /~~ **Semester** **(Strike out which is not applicable)**
8	Status	~~New /~~ **Revised** **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**From Academic Year 2017-18**

Date: **8th May, 2017** Signature :

Name of BOS Chairperson ~~/ Dean~~ : **Dr Agnelo Menezes**

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UNIVERSITY OF MUMBAI

Essentials Elements of the Syllabus

1	Title of the Course	**Foundation Course (SYBA, SYBSc, SYBCom – III and IV Semesters)**
2	Course Code	
3	Preamble / Scope	Not Applicable
4	Objective of Course / Course Outcome	Not Applicable
5	Eligibility	Not Applicable
6	Fee Structure	Not Applicable
7	No. of Lectures	**3 lectures per week**
8	No. of Practical	Not Applicable
9	Duration of the Course	**III and IV Semesters respectively**
10	Notional hours	Not Applicable
11	No. of Students per Batch	Not Applicable
12	Selection	Not Applicable
13	Assessment	Not Applicable
14	Syllabus Details	Given
15	Title of the Unit	Not Applicable
16	Title of the Sub-Unit	Not Applicable
17	Semester wise Theory	Not Applicable
18	Semester wise List of Practical	Not Applicable
19	Question Paper Pattern	Given
20	Pattern of Practical Exam	Not Applicable
21	Scheme of Evaluation of Project ~~/ Internship~~	Given
22	List of Suggested Reading	Given
23	List of Websites	Given
24	List of You-Tube Videos	Not Applicable
25	List of MOOCs	Not Applicable

UNIVERSITY OF MUMBAI

SECOND YEAR B.A., SECOND YEAR B.Sc., SECOND YEAR B.Com.

SEMESTER III AND IV

FOUNDATION COURSE

UNDER THE CBCGSS SYSTEM

EFFECTIVE FROM 2017-2018

FOUNDATION COURSE

Semester III

Internal marks: 25 **External marks: 75** **Total Marks: 100**

Lectures: 45

Objectives

i. Develop a basic understanding about issues related to Human Rights of weaker sections, ecology, and science and technology.
ii. Gain an overview of significant skills required to address competition in career choices
iii. Appreciate the importance of developing a scientific temper towards technology and its use in everyday life

Module 1 Human Rights Provisions, Violations and Redressal (12 lectures)

A. Scheduled Castes- Constitutional and legal rights, Forms of violations, Redressal mechanisms. **(2 Lectures)**
B. Scheduled tribes- Constitutional and legal rights, Forms of violations, Redressal mechanisms. **(2 Lectures)**
C. Women- Constitutional and legal rights, Forms of violations, Redressal mechanisms. **(2 Lectures)**
D. Children- Constitutional and legal rights, Forms of violations, Redressal mechanisms. **(2 Lectures)**
E. People with Disabilities, Minorities, and the Elderly population- Constitutional and legal rights, Forms of violations, Redressal mechanisms. **(4 Lectures)**

Module 2 Dealing With Environmental Concerns (11 lectures)

A. Concept of Disaster and general effects of Disasters on human life- physical, psychological, economic and social effects. **(3 Lectures)**
B. Some locally relevant case studies of environmental disasters. **(2 Lectures)**
C. Dealing with Disasters - Factors to be considered in Prevention, Mitigation (Relief and Rehabilitation) and disaster Preparedness. **(3 Lectures)**
D. Human Rights issues in addressing disasters- issues related to compensation, equitable and fair distribution of relief and humanitarian approach to resettlement and rehabilitation. **(3 Lectures)**

Module 3 Science and Technology I (11 lectures)

A. Development of Science- the ancient cultures, the Classical era, the Middle Ages, the Renaissance, the Age of Reason and Enlightenment. **(3 Lectures)**
B. Nature of science- its principles and characteristics; Science as empirical, practical, theoretical, validated knowledge. **(2 Lectures)**
C. Science and Superstition- the role of science in exploding myths, blind beliefs and prejudices; Science and scientific temper- scientific temper as a fundamental duty of the Indian citizen. **(3 Lectures)**

D. **Science in everyday life**- technology, its meaning and role in development; Interrelation and distinction between science and technology. **(3 Lectures)**

Module 4 Soft Skills for Effective Interpersonal Communication (11 lectures)

Part A (4 Lectures)

I) Effective Listening - Importance and Features.
II) Verbal and Non-Verbal Communication; Public-Speaking and Presentation Skills.
III) Barriers to Effective Communication; Importance of Self-Awareness and Body Language.

Part B (4 Lectures)

I) Formal and Informal Communication - Purpose and Types.
II) Writing Formal Applications, Statement of Purpose (SOP) and Resume.
III) Preparing for Group Discussions, Interviews and Presentations.

Part C (3 Lectures)

I) Leadership Skills and Self-Improvement - Characteristics of Effective Leadership.
II) Styles of Leadership and Team-Building.

Projects / Assignments (for Internal Assessment)

i. Projects/Assignments should be drawn for the component on Internal Assessment from the topics in **Module 1 to Module 4**.
ii. Students should be given a list of possible topics - at least 3 from each Module at the beginning of the semester.
iii. The Project/Assignment can take the form of Street-Plays / Power-Point Presentations / Poster Exhibitions and similar other modes of presentation appropriate to the topic.
iv. Students can work in groups of not more than 8 per topic.
v. Students must submit a hard / soft copy of the Project / Assignment before appearing for the semester end examination.

QUESTION PAPER PATTERN (Semester III)

The Question Paper Pattern for Semester End Examination shall be as follows:

TOTAL MARKS: 75 DURATION: 150 MINUTES

QUESTION NUMBER	DESCRIPTION	MARKS ASSIGNED
1	**i.** Question 1 A will be asked on the meaning / definition of concepts / terms from all	**a)** Total marks: 15

	Modules. **ii.** Question 1 B will be asked on the topic of the Project / Assignment done by the student during the Semester **iii.** In all 8 Questions will be asked out of which 5 have to be attempted.	**b)** For 1 A, there will be 3 marks for each sub-question. **c)** For 1 B there will be 15 marks without any break-up.
2	Descriptive Question with internal option (A or B) on Module 1	15
3	Descriptive Question with internal option (A or B) on Module 2	15
4	Descriptive Question with internal option (A or B) on Module 3	15
5	Descriptive Question with internal option (A or B) on Module 4	15

FOUNDATION COURSE

Semester IV

Internal marks: 25 **External marks: 75** **Total Marks: 100**

Lectures: 45

Module 1 Significant, contemporary Rights of Citizens (12 lectures)

A. **Rights of Consumers**-Violations of consumer rights and important provisions of the Consumer Protection Act, 2016; Other important laws to protect consumers; Consumer courts and consumer movements. **(3 Lectures)**

B. **Right to Information**- Genesis and relation with transparency and accountability; important provisions of the Right to Information Act, 2005; some success stories. **(3 Lectures)**

C. **Protection of Citizens'/Public Interest**-Public Interest Litigation, need and procedure to file a PIL; some landmark cases. **(3 Lectures)**

D. **Citizens' Charters, Public Service Guarantee Acts. (3 Lectures)**

Module 2 Approaches to understanding Ecology (11 lectures)

A. **Understanding approaches to ecology**- Anthropocentrism, Biocentrism and Eco centrism, Ecofeminism and Deep Ecology. **(3 Lectures)**

B. **Environmental Principles-1**: the sustainability principle; the polluter pays principle; the precautionary principle. **(4 Lectures)**

C. **Environmental Principles-2**: the equity principle; human rights principles; the participation principle. **(4 Lectures)**

Module 3 Science and Technology II (11 lectures)

Part A: Some Significant Modern Technologies, Features and Applications: **(7 Lectures)**

i. **Laser Technology**- Light Amplification by Stimulated Emission of Radiation; use of laser in remote sensing, GIS/GPS mapping, medical use.

ii. **Satellite Technology**- various uses in satellite navigation systems, GPS, and imprecise climate and weather analyses.

iii. **Information and Communication Technology**- convergence of various technologies like satellite, computer and digital in the information revolution of today's society.

iv. **Biotechnology and Genetic engineering**- applied biology and uses in medicine, pharmaceuticals and agriculture; genetically modified plant, animal and human life.

v. **Nanotechnology**- definition: the study, control and application of phenomena and materials at length scales below 100 nm; uses in medicine, military intelligence and consumer products.

Part B: Issues of Control, Access and Misuse of Technology. (4 Lectures)

Module 4 Introduction to Competitive Examinations (11 lectures)

Part A. Basic information on Competitive Examinations- the pattern, eligibility criteria and local centres: (4 Lectures)

i. Examinations conducted for entry into professional courses - Graduate Record Examinations (GRE), Graduate Management Admission Test GMAT), Common Admission Test (CAT) and Scholastic Aptitude Test (SAT).

ii. Examinations conducted for entry into jobs by Union Public Service Commission, Staff Selection Commission (SSC), State Public Service Commissions, Banking and Insurance sectors, and the National and State Eligibility Tests (NET / SET) for entry into teaching profession.

Part B. Soft skills required for competitive examinations- (7 Lectures)

i. Information on areas tested: Quantitative Ability, Data Interpretation, Verbal Ability and Logical Reasoning, Creativity and Lateral Thinking

ii. Motivation: Concept, Theories and Types of Motivation

iii. Goal-Setting: Types of Goals, SMART Goals, Stephen Covey's concept of human endowment

iv. Time Management: Effective Strategies for Time Management

v. Writing Skills: Paragraph Writing, Report Writing, Filing an application under the RTI Act, Consumer Grievance Letter.

Projects / Assignments (for Internal Assessment)

i. Projects/Assignments should be drawn for the component on Internal Assessment from the topics in **Module 1 to Module 4**.

ii. Students should be given a list of possible topics - at least 3 from each Module at the beginning of the semester.

iii. The Project/Assignment can take the form of Street-Plays / Power-Point Presentations / Poster Exhibitions and similar other modes of presentation appropriate to the topic.

iv. Students can work in groups of not more than 8 per topic.

v. Students must submit a hard / soft copy of the Project / Assignment before appearing for the semester end examination.

QUESTION PAPER PATTERN (Semester IV)

The Question Paper Pattern for Semester End Examination shall be as follows:

TOTAL MARKS: 75 DURATION: 150 MINUTES

QUESTION NUMBER	DESCRIPTION	MARKS ASSIGNED
1	**i.** Question 1 A will be asked on the meaning / definition of concepts / terms from all Modules.	**a)** Total marks: 15 **b)** For 1 A, there will be 3 marks for each sub-question.

	ii. Question 1 B will be asked on the topic of the Project / Assignment done by the student during the Semester **iii.** In all 8 Questions will be asked out of which 5 have to be attempted.	**c)** For 1 B there will be 15 marks without any break-up.
2	Descriptive Question with internal option (A or B) on Module 1	15
3	Descriptive Question with internal option (A or B) on Module 2	15
4	Descriptive Question with internal option (A or B) on Module 3	15
5	Descriptive Question with internal option (A or B) on Module 4	15

References

1. Asthana, D. K., and Asthana, Meera, *Environmental Problems and Solutions*, S. Chand, New Delhi, 2012.
2. Bajpai, Asha, *Child Rights in India*, Oxford University Press, New Delhi, 2010.
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7. Motilal, Shashi, and Nanda, Bijoy Lakshmi, *Human Rights: Gender and Environment*, Allied Publishers, New Delhi, 2007.

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10. Reza, B. K., *Disaster Management*, Global Publications, New Delhi, 2010.
11. Sathe, Satyaranjan P., *Judicial Activism in India*, Oxford University Press, New Delhi, 2003.
12. Singh, Ashok Kumar, *Science and Technology for Civil Service Examination*, Tata McGraw Hill, New Delhi, 2012.
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Item No. 4.33

UNIVERSITY OF MUMBAI

Syllabus for the S.Y.B.Sc.
Program: B.Sc.
Course : BOTANY

(Credit Based Semester and Grading System with effect from the academic year 2015–2016)

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

S.Y.B.Sc. Botany Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2015-2016

SEMESTER III

Course Code	UNIT	TOPICS	Credits	L / Week
USBO301		**PLANT DIVERSITY II**		
	I	Thallophyta- Algae	2	1
	II	Bryophyta		1
	III	Angiosperms		1
USBO302		**FORM AND FUNCTION II**		
	I	Instrumentation and Techniques	2	1
	II	Cell Biology		1
	III	Cytogenetics		1
USBO303		**CURRENT TRENDS IN PLANT SCIENCES I**		
	I	Pharmacognosy&Phytochemistry	2	1
	II	Forestry & Economic Botany		1
	III	Molecular Biology		1
USBOP3	Practical based on all the three courses in theory		3	9

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER IV

Course Code	UNIT	TOPICS	Credits	L / Week
USBO401		**PLANT DIVERSITY II**		
	I	Thallophyta: Fungi, Plant Pathology and Lichens	2	1
	II	Pteridophyta and Paleobotany		1
	III	Gymnosperms		1
USBO402		**FORM AND FUNCTION II**		
	I	Anatomy	2	1
	II	Physiology and Plant Biochemistry		1
	III	Ecology and Environmental Botany		1
USBO403		**CURRENT TRENDS IN BOTANY I**		
	I	Horticulture	2	1
	II	Biotechnology		1
	III	Biostatistics & Bioinformatics		1
USBOP4	Practical based on all the three courses in theory		3	9

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER III
THEORY

Course Code	Title	Credits
USBO301	**PLANT DIVERSITTY II**	**2 Credits (45 lectures)**
Unit I : Thallophyta- Algae • General Characters of Division Phaeophyta: Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction: asexual and sexual, Alternation of Generations, Economic Importance. • Structure, life cycle and systematic position of *Dictyota* *Sargassum* • Pigments in Algae.		**15 Lectures**
Unit II : Bryophyta • General Account of Class Anthocerotae and Musci • Structure, life cycle and systematic position of o *Anthoceros* o *Funaria*		**15 Lectures**
Unit III : Angiosperms **Morphology of Flowering Plants** • **Flower Morphology :** o Parts of a flower, flower symmetry; o Flower as a modified shoot, o Thalamus, insertion of floral leaves on the thalamus o The accessory whorls : Calyx types and modifications, Corolla – forms; Aestivation, The Perianth; o The Essential whorls: Androecium parts of the androecium, Number and insertion of stamens, Union of stamens; Types of CoronaGynoecium: the carpel, style and stigma; Union of Carpel; ovary- placentation, types of ovules, evolution of placenta in Angiosperm. o Floral formula, floral diagram. • With the help of Bentham and Hooker's system **of classification for flowering plants**study the vegetative, floral characters and economic importance of the following families: o Magnoliaceae o Myrtaceae o Asteraceae o Apocynaceae o Amaranthaceae o Palmae		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Course Code	Title	Credits
USBO302	**FORM AND FUNCTION II**	**2 Credits (45 lectures)**
Unit I : Instrumentation and Techniques • Microscopy – Principle and working of Light, and electron microscope. • Chromatography- Principles and techniques in paper and thin layer chromatography. • Principles and techniquesof Horizontal and Vertical electrophoresis.		**15 Lectures**
Unit II : Cell Biology • Ultra Structure and functions of the following cell organelles: o Mitochondrion o Peroxisomes o Glyoxysomes o Ribosomes • Cell Division and its significance o Cell Cycle o Mitosis &Meiosis o Differences between Mitosis and Meiosis • Nucleic Acids: Types, structure and functions of o DNA o RNA		**15 Lectures**
Unit III : Cytogenetics • **Variation in Chromosome structure (Chromosomal Aberrations)** Definition, Origin, Cytological and Genetic Effects of the following: Deletions, Duplications, Inversions and Translocations. • **Variation in Chromosome Number** Origin and production, morphological and cytological features, applications in crop improvement and evolution of Aneuploids and Euploids(Monoploids, Autopolyploids and allopolyploids) • **Extranuclear Genetics** Organelle heredity- o Chloroplast determines heredity -Plastid transmission in plants, Streptomycin resistance in *Chlamydomonas*. o Mitochondrion determined heredity- petite colonies in yeast		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Course Code	Title	Credits
USBO303	**CURRENT TRENDS IN PLANT SCIENCES I**	**2 Credits (45 lectures)**
Unit I : Pharmacognosy and Phytochemistry • Introduction to pharmacopoeia • Study of secondary metabolites (sources, properties and uses) with reference to o Alkaloids, o Glycosides, o Tannins, o Volatile oils and o Gums and resins (example of one plant for each category)		**15 Lectures**
Unit II : Forestry and Economic Botany • **Types of forests** – classification of forests, different types of forests in India • **Applications of forestry**- Social forestry, Reforestation, Aforestation, Deforestation. • **Economic Botany**: o Fibres: Types of fibres, fibre yielding plants o Paper: Types of paper, paper yielding plants, paper processing. o Spices and condiments: Nutmeg, Mace, Clove, Cardamom and Saffron		**15 Lectures**
Unit III : Molecular Biology • **DNA replication** : Replication(prokaryotic and eukaryotic) • **Protein Synthesis**: o Central dogma of Protein synthesis o Transcription: The transcription process in prokaryotes and eukaryotes, RNA synthesis, RNA processing, Adenylation& Capping.		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER III
PRACTICAL

Semester III USBOP3 PRACTICAL Paper I – Plant Diversity II	Cr 1

Algae

1. Study of stages in the life cycle of *Dictyota*from fresh/ preserved material and permanent slides.
2. Study of stages in the life cycle of *Sargassum* from fresh/ preserved material and permanent slides.
3. Economic importance and range of thallusinPhaeophyta

Bryophyta

4. Study of stages in the life cycle of *Anthoceros*from fresh/ preserved material and permanent slides.
5. Study of stages in the life cycle of *Funaria*from fresh/ preserved material and permanent slides.

Angiosperms

6. Study of Floral Morphology

7- Study of one plant from each family prescribed for theory: morphological

9. peculiarities and economic importance of the members of these families.

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Semester III USBOP3 PRACTICAL Paper II – FORM AND FUNCTION- II	Cr 1
Instrumentation and Techniques 1 Preparation of herbarium and wet preservation technique 2 Chromatography: Separation of amino by circular paper chromatography 3 Separation of Carotenoids by thin layer chromatography 4 Horizontal and Vertical Gel Electrophoresis – Demonstration **Cell Biology** 5 Study of the ultra-structure of cell organelles prescribed for theory from Photomicrographs 6 Estimation of DNA from plant material (one Std& one Unknown, No Std Graph) 7 Estimation of RNA from plant material (one Std& one Unknown, No Std Graph) **Cytogenetics** 8 Study of inheritance pattern with reference to Plastid Inheritance **9**Aberrations --- karyotypes - Cri – du- chat, Philadelphia, D-G translocation, DownSyndrome.	

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Semester III USBOP3	Cr
PRACTICAL - Paper III CURRENT TRENDS IN PLANT SCIENCES I	**1**

Pharmacognosy

1 A. Tests for alkaloids from *Strychnos*(seeds) and*Holarrhena*(bark)
B. Tests for glycosides from *Glycyrrhiza*rhizome/ *Aloe* leaf/ Senna leaf.
2 Preparation of any herbal cosmetic.(Demonstration)
3 Stomatal Index
4 Palisade Ratio, Vein islet number

Forestry and Economic Botany

5 Study of Biodiversity Composition of different types of forests in India (tropical, subtropical & temperate)
6 Sources, properties and uses of : fibres & paper
7 Sources , properties and uses of spices and condiments

Molecular Biology

8 DNA sequencing- Sanger's method
9 Determining the sequence of amino acids in the protein molecule synthesised from the given m-RNA strand (prokaryotic and eukaryotic)

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER IV
THEORY

Course Code	Title	Credits
USBO401	**PLANT DIVERSITY II**	**2 Credits (45 lectures)**
Unit II : Thallophyta: Fungi, Plant Pathology and Lichens **Fungi-** • General characters of Ascomycetae • Structure, life cycle and systematic position of *Erysiphe and Xylaria* **Plant Pathology-** • Symptoms, causative organism, disease cycle and control measures of o Powdery mildew and o Late blight of potato **Lichens-** • Classification, Structure, Method of Reproduction, Economic Importance and Ecological Significance of Lichens.		**15 Lectures**
Unit II : Pteridophyta and Paleobotany **Pteridophyta-** • Salient features and classification upto orders (with examples of each) of Psilophyta and Lepidophyta (G M Smith's system of classification to be followed), • Structure, life cycle and systematic position of *Selaginella* **Paleobotany-** • The geological time scale; • Formation and types of fossils; • Structure and systematic position of form genus *Rhynia*		**15 Lectures**
Unit III : Gymnosperms • Salient features, classification up to orders (with examples of each) and economic importance of Coniferophyta (Chamberlain's system of classification to be followed) • Structure life cycle and systematic position of *Pinus* • Structure and systematic position of the form genus *Cordaites*		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Course Code	Title	Credits
USBO402	**FORM AND FUNCTION II**	**2 Credits (45 lectures)**

Unit I : Anatomy
• Normal Secondary Growth in Dicotyledonous stem and root.
• Secondary growth in Monocot stem – *Dracaena.*
• Mechanical Tissue system
  o Tissues providing mechanical strength and support and their disposition
  o I-girders in aerial and underground organs
• Conducting tissue system :
  o Xylem and its elements,
  o Phloem and its elements
  o Types of Vascular Bundles.
		15 Lectures

Unit II : Plant Physiology and Plant Biochemistry • **Respiration: Aerobic:** Glycolysis, TCA Cycle, ETS &Energetic of respiration; Anaerobic respiration. • **Photorespiration** • **Photoperiodism:**Phytochrome Response and Vernalization with reference to flowering in higher plants, Physico-chemical properties of phytochrome, Pr-Pfrinterconversion, role of phytochrome in flowering of SDPs and LDPs; • **Vernalization** mechanisms and applications.		**15 Lectures**
Unit III : Ecology and Environmental Botany • Biogeochemical Cycles- Carbon, Nitrogen and Water. • Ecological factors: Concept of environmental factors. Soil as an edaphic factor, Soil composition, types of soil, soil formation, soil profile. • Community ecology- Characters of community - Quantitative characters and qualitative characters		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

Course Code	Title	Credits
USBO403	**CURRENT TRENDS IN PLANT SCIENCES I**	**2 Credits (45 lectures)**
Unit I : Horticulture and Gardening • **Introduction to Horticulture**:Branches of Horticulture • **Gardening:** o Locations in the garden- edges, hedges, lawn, flower beds, avenue, water garden (with names of two plants for eachcategory). Focal point. • **Types of gardens** o Formal and informal gardens, o National Park: Sanjay Gandhi National Park. o Botanical Garden: Veer Mata JijabaiUdyan (Victoria Garden).		**15 Lectures**
Unit II : Biotechnology • **Introduction to plant tissue culture** o Laboratory organization and techniques in plant tissue culture o Totipotency o Organogenesis o Organ culture – root cultures, meristem cultures, anther and pollen culture, embryo culture. • **R-DNA technology-** o Gene cloning o Enzymes involved in Gene cloning o Vectors used for Gene cloning.		**15 Lectures**
Unit III : Biostatistics and Bioinformatics • **Biostatistics:** o The chi square test. o Correlation – Calculation of coefficient of correlation. • **Bioinformatics** o Information technology: History and tools of IT, Internet and its uses**.** o Introduction to Bioinformatics- goal, need, scope and limitation o Aims of Bioinformatics: Data organization, Tools of Bioinformatics- tools for web search, Data retrieval tools- Entrez, o BLAST o Bioinformatics programme in India.		**15 Lectures**

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER IV
PRACTICAL

Semester IV USBOTP4 PRACTICAL Paper I – Plant Diversity	Cr 1
Fungi and Plant Pathology 1 Study of stages in the life cycle of *Erysiphe*from fresh/ preserved material and permanent slides. 2 Study of stages in the life cycle ofXylaria from fresh/ preserved material and permanent slides. 3 Study of fungal diseases as prescribed for theory. 4 Study ofLichens (crustose, foliose, &fruiticose). **Pteridophyta and Palaeobotany** 5-6 Study of stages in the life cycle of *Selaginella*from fresh/ preserved material and permanent slides. 7 Study of form genera *Rhynia*with the help of permanent slides/ photomicrographs. **Gymnosperms** 8- Study of stages in the life cycle of *Pinus*from fresh/ preserved material and 9 permanent slides. 10 Study of the form genus *Cordaites*with the help of permanent slide/ photomicrographs.	

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER IV USBOT P4 PRACTICALS Paper II – FORM AND FUNCTION- II	Cr 1

Anatomy

1 Study of normal secondary growth in the stem and root of a Dicotyledonous plant
2 Study of secondary growth in monocot stem (*Dracena*).
3 Types of mechanical tissues, mechanical tissue system in aerial, underground organs.
4 Study of conducting tissues- Xylem and phloem elements in Gymnosperms and Angiosperms as seen in LS and through maceration technique.
5 Study of different types of vascular bundles.

Plant Physiology and Plant Biochemistry

6 Q_{10} – germinating seeds using Phenol redindicator
7 NR activity – *in-vivo*
8 Estimation of proteins by Lowry's method (Prepare standard graph).

Ecology and Environmental Botany

9 Study of the working of the following Ecological Instruments- Soil thermometer, Soil testing kit, Soil pH, Wind anemometer.
10 Mechanical analysis of soil by the sieve method & pH of soil.
11 Quantitative estimation of organic matter of the soil by Walkley and Blacks Rapid titration method.
12 Study of vegetation by the list quadrat method

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

	Cr
SEMESTER IV USBOP4	
PRACTICALS - Paper III – CURRENT TRENTS IN PLANT SCIENCES	**1**

Horticulture

1 Study of five examples of plants for each of the garden locations as prescribed for theory
2 Preparation of garden plans – formal and informal gardens
3 Bottle and dish garden preparation.

Biotechnology

4 Various sterilization techniques
5 Preparation of Stock solutions, Preparation of MS medium.
6 Seed sterilization, callus induction
7 Regeneration of plantlet from callus
8 Identification of the cloning vectors – pBR322, pUC 18, Ti plasmid.

Biostatistics and Bioinformatics

9 Chi square test
10 Calculation of coefficient of correlation
11 Web Search – Google, Entrez.
12 BLAST

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER - III, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – I** **Total Marks – 50**

Q.1. Identify, Classify and describe specimen **'A'** . Sketch neat and labeled diagram. (10)

Q.2. Identify, Classify and describe specimen **'B'** . Sketch neat and labeled diagram. (10)

Q.3. Assign the specimen **'C'** to its family giving reasons. Give the distinguishing characters, floral Diagramand floral formula. Sketch the L.S. of flower and T.S. of ovary. (10)

Q.4. Identify and describe the specimen/ slide/ photograph -**'D', 'E', 'F' , 'G'** and **'H'**. (15)

Q.5. Journal. (05)

KEY :

A. – *Dictyota / Sargasum*

B. –*Anthoceros / Funaria*

C. Any Angiospermic Family as per syllabus.

D. Algae – economic importance / range of thallus in Phaeophyta

E. *Anthoceros / Funaria*

F. Calyx / Corolla (any one type)

G. Androecium / Gynoecium (any one type)

H. Economic importance or morphological peculiarity of any one family.

SEMESTER - III, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – II** **Total Marks – 50**

Q.1. To Separate given material 'A' by any appropriate chromatography technique . (10)

Q.2. To estimate DNA/ RNA from the given sample 'B'. (10)

Q.3. Make an Idiogram from the given Karyotype 'C'. Identify and enlist the symptoms of the chromosomal abberation. (10)

Q.4. Identify and describe the specimen/ photograph - 'D' (05), 'E' (05) and 'F' (05 or 03 + 02). (15)

Q.5. Field Report. (05)

KEY :

A. – Carotenoids/amino acids

B. Cauliflower

C. Cri-du-chat; Philadelphia; D-G translocation, DownSyndrome

D. Electrophoresis

E. *Dry* or wet preservation

F. Cell organelles / Plastid inheritance.

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER - III, , S.Y.B.Sc. BOTANY

PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – III** **Total Marks – 50**

Q.1. a). Identify the active constituents present in specimen **'A'** by performing suitable chemical tests. (08)

Q.1. b).Calculate the stomatal index / palisade ratio / vein – islet numbers from the given specimen **'B'**. (07)

Q.2. Describe the ecological factors, enlist the dominant flora and mark the area on the map of a forest type **'C'** . (10)

Q.3. Determine the sequence of bases in a DNA strand by Sanger's method from the given data **'D'or** Determine the sequence of amino acids in the polypeptide synthesized from the given m-RNAstrand **'D'** (08)

Q.4. Identify and describe the specimen/ slide/ photograph - **'E', 'F' , and 'G'.** (12)

Q.5. Viva - Voce. (05)

KEY :

A. Alkaloids / Glycosides.

B.Betel leaf / *Vinca*leaf.

E. Importance of _____ in herbal cosmetics.

F. Fibres / Paper.

G. Spices / Condiments.

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER - IV, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – I** **Total Marks – 50**

Q.1. Identify, Classify and describe specimen **'A'** . Sketch neat and labeled diagram. (10)

Q.2. Identify, Classify and describe specimen **'B'** . Sketch neat and labeled diagram. (10)

Q.3. Identify, Classify and describe specimen **'C'** .Sketch neat and labeled diagram. (10)

Q.4. Identify and describe the specimen/ slide/ photograph -**'D', 'E' and 'F' .** (15)

Q.5. Journal. (05)

KEY :

A. – *Xylaria / Erysiphe*

B. –*Selaginella – Stem / strobilus*

C. *Pinus – needle* / stem / male cone.

D. Fungal disease – Powdery mildew / any other disease as per syllabus.

E. Lichen.

F. *Rhynia / Cordaites.*

SEMESTER - IV, ,S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – II** **Total Marks – 50**

Q.1. a). Make a temporary stained preparation of T.S. of specimen **'A'** and comment on the secondary growth . (10)

Q.1. b). Make a temporary stained preparation of T.S. of specimen **'B'** and comment on the mechanical tissue system .

OR

Macerate the given material 'B' and describe the conducting tissue seen. (05)

Q.2. Perform the Physiological experiment **'C'** allotted to you . (12)

Q.3. Perform the Ecological experiment **'D'** allotted to you . (12)

Q.4. Identify and describe the specimen/ slide/ photograph - **'E', and 'F' .** (06)

Q.5. Viva - Voce. (05)

KEY :

A. – Dicot stem/ dicot root / monocot stem.

B. –Mechanical Tissue (*Coleus stem, Typha leaf, Maize stem and* Maize root /*Annona / Magnolia*formaceration).

E. – Vascular bundles / phloem/xXylem.

F. – Ecological Instrument.

Syllabus for the S.Y.B.Sc. Program: B.Sc.Course : BOTANY

SEMESTER - IV, , S.Y.B.Sc. BOTANY

PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – III** **Total Marks – 50**

Q.1. Prepare a garden plan **'A'** . Mention any three garden locations with suitable plants (Botanical names). (10)

Q.2. Prepare MS medium **OR** Perform seed sterilization technique **'B'** . (08)

Q.3. a). Perform Chi- square test **OR** Coefficient of Correlation using the given data **'C'** and analyse the results . (12)

Q.3.b). Perform the experiment **'D'** related to Web search. (06)

Q.4.a). Identify and describe the specimen/ photograph -**'E'** (05)

Q.4.b). Identify and describe the specimen/ photograph - **'F', 'G' and 'H' .** (09)

KEY :

E. Bottle or dish garden.

F. Sterilization Technique.

G. Cloning Vectors.

H. Bioinformatics.

AC_11-5-2017

Item No._____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**S. Y. B. Sc. Chemistry**
2	**Eligibility for Admission**	F. Y. B. Sc. Passed from this university (or with ATKT in any two courses at the F. Y. B. Sc. Level) or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this university
3	**Passing marks**	**40%**
4	**Ordinances/Regulations (if any)**	
5	**No. of Semesters**	**Two**
6	**Level**	**U.G.**
7	**Pattern**	**Semester**
8	**Status**	**New**
9	**To be implemented from Academic year**	**2017-2018**

Date : 05-5-2017 **Signature:**
BoS Chairperson: **Dr. Anil V. Karnik**
Convener: Dr. Ravindra G. Deshmukh

UNIVERSITY OF MUMBAI

Essentials Elements of The Syllabus

1	**Title of Course**	Syllabus for two semester S. Y. B. Sc. course in chemistry
2	**Couse Code**	USCH301, USCH302, USCH303 USCH401, USCH402, USCH404 USCHP1 to USCHP6
3	**Preamble**	Attached
4	**Objective**	• To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry. • To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course. • To make the learner capable of solving problems in the various units of this course • To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry • To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling • To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
5	**Eligibility**	Pass F. Y. B. Sc.
6	**Fee Structure**	As Per Guidelines issued from the University
7	**No. of Lectures**	9 lectures per week (three lectures per paper)
8	**No. of Practicals**	9 periods per week (three periods per paper)
9	**Duration of Course**	Two Semester

10	**Notional Hours**	72 hours per paper per semester Theory and 36 hours per paper per semester for laboratory sessions
11	**No of students per batch**	120 students per division (20 Students for laboratory sessions)
12	**Selection**	As per merit.
13	**Assessment**	**End of semester examination of 100 marks per paper for theory and 50 marks per paper for laboratory sessions**
14	**Syllabus Detail**	**Attached**
15	**Title of the Unit**	**As given in the Syllabus text**
16	**Title of the Sub-unit**	**As given in the syllabus text.**
17	**Semester wise Theory**	**As prescribed in the syllabus text**
18	**Semester wise Practicals**	**As prescribed in the syllabus text.**
19	**Question Paper Pattern**	**As prescribed by the Faculty of Science**
20	**Scheme of evaluation of Project**	**N.A.**
21	**List of suggested reading**	**As Attached**
22	**List of websites**	**As Attached**
23	**List of You Tube videos**	**As attached**
24	**List of MOOCs**	**As Attached**

REGULATIONS

1. **Preamble and objectives of the Course :**

In the first two semseters of the six semester graduation program of B. Sc.(Chemistry) the learner was introduced to some basic aspects in the various core branches of chemistry like Physical Chemistry, Organic chemistry and Inorganic chemistry. Concepts about the structure of atom, distribution of electrons, Thermodynamics, Formation of organic compounds and basic ideas in reactivity of molecules in general and organic compounds in particular were introduced to the learner. He was made inquisitive about why and how should atoms combine to give molecules or ions. The non-orbital approach to appreciating the shapes of polyatomic species in general and molecules in particular.

The story of chemistry is taken further in the coming two semesters of the second year of the B. Sc. (Chemistry) Program. However it is also realised that some students opting for the course on Chemistry may not continue with the subject subsequently as such the syllabus is designed to retain the interest of the serious learner of chemistry as well as be helpful to non-chemistry learners. With such students who would want to pursue other branches of science but would want to acquire a basic appreciation and experience of chemistry a separate paper (Paper-III) is designed. This paper along with the laboratory session unit that goes with it deals with the basics of chemical analysis, separating components from a given sample, basic concepts like pH, experimental techniques like Titrimetry, Gravimetry, using instruments to carry out analysis, the various techniques like chromatography, electrophoresis, Instrumentation in general is felt to be of interest to learners of various branches like physics, botany, zoology, and microbiology.

The major objectives of B.Sc. Chemistry course are

- To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.

- To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course.
- To make the learner capable of solving problems in the various units of this course
- To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
- To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling
- To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
- To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry
- To arouse the interest to pursue higher levels of learning in chemistry,

2. Condition for Admission

A candidate who has passed the F.Y.B.Sc. of Mumbai University or an examination of some other university accepted by the syndicate as equivalent there to with Chemistry, Physics, Maths, Botany, Zoology or Life Science shall be eligible for admission into S.Y.B.Sc., course in Chemistry.

To

3. Duration of the Course: one year

4. Course of study:

Draft copy of the proposed revised syllabus for
Choice Based Credit System
S.Y.B.Sc. Chemistry
To be implemented from the Academic year 2017-2018

For the subject of chemistry there shall be three papers for 45 lectures each comprising of three units of 15 L each.

Semester-III

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry

Semester-IV

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
   Basics of Analytical Chemistry
3. Paper III

Choice Based Credit System
S. Y. B. Sc.
Chemistry Syllabus
To be implemented from the Academic year 2017-2018

Course Content
Semester III

Course Code	Unit	Topics	Credits	L/Week
USCH301	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USCH302	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USCH303	I	Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis.		1
	III	Instrumental Methods-I		1
USCHP1		Chemistry Practicals I	1	3
USCHP2		Chemistry Practicals II	1	3
USCHP3		Chemistry Practicals III	1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USCH401	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Sulphonic acids		1
USCH402	I	Solid state, Catalysis	2	1
	II	Ions in aqeous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Amines, Diazonium salts, Heterocyclic compounds		1
USCH403	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USCHP4		Chemistry Practicals I	1	3
USCHP5		Chemistry Practicals II	1	3
USCHP6		Chemistry Practicals III	1	3

Semester III
Paper I
Theory: 45 Lectures

Unit I:Physical Chemistry

1.1 Chemical Thermodynamics-II(8L)

1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's
free energy with Pressure and Temperature.
1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore.
(Numericals expected).
1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.
1.1.4 Concept of Fugacity and Activity

1.2 Electrochemistry: (7L)

1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.
1.2.2 Kohlrausch law of independent migration of ions.
1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected).
1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.

Unit-II
Chemical Bonding

2.1 Non-Directional Bonding (4L)

2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond.
2.1.2 Types of Ionic Crystals
2.1.3 Radius Ratio Rules
2.1.4 Lattice Energy, Borne-Lande Equation
2.1.5 Kapustinski Equation
2.1.6 Born-Haber Cycle and its Application

2.2. Directional Bonding: Orbital Approach. (6L)

2.2.1 Covalent Bonding The Valence Bond Theory- Introduction and basic tenets.

2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system.

2.2.3 Corrections applied to the system of two hydrogen atoms- Formation of H_2

2.2.4 Homonuclear diatomic molecules from He_2 to Ne_2

2.2.5 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.

2.2.6 Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, $sp^2d^2$and sp^2d sp^3d^2*.

2.2.7 Equivalent and Non-Equivalent hybrid orbitals

2.2.8 Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3)

2.3 **Molecular Orbital Theory (5L)**

2.3.1. Comparing Atomic Orbitals and Molecular Orbitals.

2.3.2. Linear combination of atomic orbitals. to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules).

2.3.4. Wave mechanical treatment for molecular orbitals (H_2^+ and H_2)

2.3.4 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-}

(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry

3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]

3.1.1.**Alkyl halides:** Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group.

3.1.2.**Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzyne mechanism.

3.1.2.**Organomagnesium and organolithium compounds: [3L]**

Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides and epoxides.

3.2 Alcohols, phenols and epoxides: [8L]

3.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols

3.2.2. **Phenols: Pr**eparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.

3.2.3. **Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.

Semester III
Paper II

Unit I: Physical Chemistry

1.1 Chemical Kinetics-II (7L)

1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected),

Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected).

1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected).

1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories

(Qualitative treatment only)

1.2 Solutions: (8 L)

1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature -composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.

1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems

1.2.3 Immiscibility of liquids- Principle of steam distillation.

1.2.4 Nernst distribution law and its applications, solvent extraction.

Unit-II

2. Selected topics on p block elements (15L)

2.1 Chemistry of Boron compounds

2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.
2.1.2 Preparation of simple boranes like diborane and tetraborane.
2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)
2.1.4 Synthesis of Borax.

2.2 Chemistry of Silicon and Germanium

2.2.1 Silicon compounds: Occurrence , Structure and inertness of SiO_2
2.2.2 Preparation of structure of $SiCl_4$
2.2.3 Occurrence and extraction of Germanium
2.2.4 Preparation of extra pure Silicon and Germanium

2.3 Chemistry of Nitrogen family

2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.
2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4.
2.3.3 Synthesis of ammonia by Bosch – Haber process.

Unit III: Organic Chemistry

Carbonyl Compounds: [15L]

3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes

3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.

3.3 Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.

3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction.

3.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization

3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)

Semester IV
Paper I

Unit I: Physical Chemistry

1.1Electrochemistry-II: (8 L)

1.1.1 Electrochemical conventions, Reversible and irreversible cells.

1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected).

1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected)

1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected)

1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

1.1.6 pH determination using hydrogen electrode and quinhydrone electrode.(Numericals expected)

1.2 Phase Equilibria: (7L)

1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.

1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (numericals expected)

1.2.3 Phase diagrams of one-component systems (water and sulphur).

1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).

Unit-II

2.1 Comparative Chemistry of the transition metals (9 L)

2.1.1 Position in the periodic table; Natural occurrence principal ores and minerals;

2.1.2 Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)

2.1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer).

2.1.4 Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments.

2.1.5 Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis

2.1.6 Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper)

2.2 Coordination Chemistry : (6 L)

2.2.1 Introduction to Chemistry of Coordination Compounds

i. Historical perspectives: Early ideas on coordination compounds
ii. Basic terms and nomenclature.
iii. Types of ligands
iv. Isomerism :General Types with special reference to stereoisomerism of coordination compounds (C.N=6)
v. Evidence for the formation of coordination compounds,

2.2.2. Theories of coordination compounds

i. Werner's Theory of coordination compounds,
ii. Effective atomic number rule.
iii. Eighteen electron Rule

2.2.3. Nature of the Metal-Ligand Bond:

i. Valence Bond Theory; Hybridisation of the central metal orbitals-sp^3, sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d,
ii. Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II),Fe(III),Co(II)/Co(III),Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used)
iii. Limitations of V.B.T

2.2.4. Application of coordination compounds.

Unit III: Organic Chemistry

3.1 Carboxylic Acids and their Derivatives :(11 Lectures)

3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.

3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles.

3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction,Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity.

3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.
3.1.5. Mechanism of Claisen condensation and Dieckmann condensation.

3.2 Sulphonic acids: [4L]

Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation.Reaction with alcohol, phosphorous pentachloride, IPSO substitution.

Semester IV
Paper II

Unit I: Physical Chemistry

1.1 Solid State: (7L)

1.1.1 Recapitulation of laws of crystallography and types of crystals

1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected)

1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation

1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.

1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)

1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

Unit-II

2 Ions in aqeous medium

2.1. Acidity of Cations and Basicity of Anions

i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radious.

ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation

iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples

iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions-concept, diagram classification on the basis of basicity

2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids

i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid

ii. Uses and environments aspects of these acids

Unit III: Organic Chemistry

Nitrogen containing compounds and heterocyclic compounds:

3.1 Amines: Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines;

3.1.1. Preparation: Reduction ofaromaticnitro compounds using catalytic hydrogenation,chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction.

3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.

3.2 Diazonium Salts: **(7 Lectures)**

Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene

3.3 Heterocyclic Compounds: (8 Lectures)

3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom;

3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),

3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.

3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.

3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

Semester III
Chemistry Practicals:

Unit I: Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. To determine the critical solution temperature (CST) of phenol - Water System.
4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
6. To determine solubility of sparingly soluble salts (anytwo) conductometrically.

Unit II: Inorganic Chemistry

1. Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]
2. Crystallisation of potassium iodate and to estimate its purity before and after the separation.
3. Estimation of total hardness
4. Investigation of the raction between Copper supfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

Unit III: Organic Chemistry

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β-Naphthylbenzoate
5. m-Dinitrobenzene from nitrobenzene

6. Phthalic anhydride from phthalic acid by sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

(Any eight preparations)

Semester IV
Chemistry Practicals:

Unit I: Physical Chemistry

1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically .
2. To determine the amount of HCl in the given sample potentiometrically.
3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate.
6. Industrial visit report.

Unit II: Inorganic Chemistry

1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.
2. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate.
3. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion hexanitrocobaltate(III) and its use to precipitate a large cation (potassium)
4. Inorganic salt – Calcium or magnesium oxalate using PFHS technique

Unit III: Organic Chemistry

Qualitative Analysis of bi-functional organic compounds on the basis of

1. **Prelimenary examination**
2. **Solubility profile**
3. **Detection of elements C, H, (O), N, S, X.**
4. **Detection of functional groups**
5. **Determination of physical constants (M.P/B.P)**

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysisto be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.

Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed)

Reference Books for Practicals:

Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar

5. **References.**

6. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
7. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
8. Chemistry of Transition Elements Pg.- 608 – 679 .
9. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
10. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
11. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
12. CNR Rao edited, University General Chemistry, 513-578.
13. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
14. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
15. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
16. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
17. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
18. Bruce H. Mahan, University Chemistry, Narosa publishing house.
19. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
20. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
21. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
22. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
23. CNR Rao edited, University General Chemistry
24. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,

25. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
26. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
27. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
28. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Semester III
Paper III
Basics in analytical Chemistry
Theory: 45 Lectures

The Role of Analytical chemistry in various fields including non-chemistry fields such as Environmental Science, Pharmacy, Medicine, Life Sciences, Petrochemicals, Arts (like Painting) Forensic sciences and so on can never be underestimated. This course is expected to introduce the learner to this interesting field of Analytical Chemistry.

It is expected to provide the learner an overview of this very important branch of chemistry. After successful completion of this course the learner is expected to be familiar with the question of what is analysis, why it is required and the methods, techniques, procedures and protocols that may be used or required in the course of a given problem of analysis. The learner is also expected to appreciate the role of an Analytical Chemist and a Chemical Analyst.

Correctness or acceptability of the results of a given analysis and how to deal with wrong or erroneous results: when to reject them and when and how to retain them to be meaningful and/or acceptable are some other attributes expected as outcomes of learning this paper.

As such it is felt that this paper will be a subject of choice and interest for learners preferring a specialisation in Chemistry as well as to those who may have interests in other science fields as Physics, Botany, Zoology, Microbiology, Geochemistry and so on.

Goal:

To introduce the learner to an area of learning that is vital for the inherent nature of the subject itself but also is important and irreplaceable irrespective of the long term interest of specialisation or subject of interest of the learner.

Unit **I- Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I (15 L)**

Scope/ Objectives:

Learners should be able to

1. Select a method of analysis
2. Decide how to identify a sample and prepare it for analysis
3. Select a procedure for analysis
4. Identify sources of possible errors in the results obtained.

(Problems including numericals expected wherever necessary)

1.1. Role of Analytical Chemistry (9 L)

1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry.

1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)

1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance.

1.2. Significance of Sampling in Analytical Chemistry

1.2.1. Terms involved in Sampling

1.2.2. Types of Sampling

1.2.3. Sampling techniques

1.3. Results of Analysis. (6L)

1.3.1. Errors in Analysis and their types

1.3.2. Precision and Accuracy in Analysis

1.3.3. Corrections for Determinate Errors

(Problems including Numericals expected wherever required)

References:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch

2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.;
Dean, J.A.; Settle,7th Edition

3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler,
S. R. Crouch

4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

Unit II- Classical Methods of Analysis(15 L)

Objectives:

The main objectives of this unit is to

- Introduce classical methods of chemical analysis.
- Appreciate the various terms and types of titrimetric analysis.
- Ability to select proper titrimetric method
- Appreciate the usefulness of the gravimetric method of analysis
- Identify a suitable gravimetric method
- Perform the required calculations involved in the analysis by titrimetry as well as gravimetry.

2. Classical Methods of Analysis. (04L)

2.1. Titrimetric Methods

2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry

2.1.2. The Conditions suitable for titrimetry

2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations

2.1.4. Tools of Titrimetry: Graduated glasswares and Callibration

2.2. Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry.

2.3. Neutralisation Titrations (04L)

2.3.1. Concept of pH and its importance in Neutralisation Titrations

2.3.2. End point and Equivalence point of Neutralisation titrations

2.3.3. Determination of End point by using

i. Indicators causing colour change
ii. Change in potential, (by potentiometry)
iii. Change in conductance (by conductometry)

2.3.4. Construction of titration curve (on the basis of change in pH)of a titration of

i. Strong acid-weak base
ii. Strong base-weak acid

2.4. Gravimetric analysis (06 L)

2.4.1. General Introduction to Gravimetry.

2.4.2. Types of Gravimetric Methods –

2.4.3. Precipitation Gravimetry:

i. Steps involved in precipitation gravimetry analysis
ii. Conditions for precipitation
iii. Completion of precipitation,
iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.

v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it to its oxide.

References:

1) Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15
2) Day and Underwood, “Quantitative analysis" prentice hall 1991, chapter3
3) S.M. Khopkar, “ Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher
4) Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley Students Edition, Chapter No 8,9,10
5) Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
6) Modern Analytical Chemistry , David Harvey (page numbers 232 -265)

Unit III: Instrumental Methods-I [15 L]

Objectives:

On completing the learning of this unit the learner is expected to

- Know the various instrumental methods of analysis
- Advantages of using instruments to make measurements
- The various observable properties of a given analyte and the stimulus best suited for its analysis
- Know about a generalized diagram of an analytical instrument
- Select a suitable instrumental method for analysis
- Appreciate the basic terms in spectrometry
- Use the relationship between absorbance (and its variations) and concentration of the analyte.
- Chose a suitable method foe photometric titrations.

3. Basic Concepts in Instrumental methods (03)

3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property.

3.2. Block Diagram of an Analytical instrument.

3.3. Types of Analytical Instrumental methods based on

i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
iii. Thermal interactions (eg. Thermogravimetry)

3.4. Spectrometry (07 L)

3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy

3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic

light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbtivity

3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer -Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)
(Numerical problems based on Beer-Lambert's Law)

3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers

3.4.5. Block Diagrams for Single beam and Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e , source ,Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube)

3.4.6. Applications of UV-Visible Spectrophotometry **(02 L)**

(a) Qualitative analysis such as Identification of functional groups in Organic compounds ,Chromophores and Auxochrome,c*is* and *trans* isomers

(b) Quantitative analysis by Calibration curve method and

3.4.7. Photometric Titrations: Principle ,Instrumentation, Types of Photometric titration Curves with examples. **(03L)**

References:

1.Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K.Anand pp 2.107-2.148

2.Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.

3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.

Semester III
Chemistry Practicals:
Paper III
Basics in Analytical Chemistry

1. **Tools of Analytical Chemistry-I:**
   a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.
   b) Weighing tools such as two pan balance and monopan balance, digital balances:
   c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
   d) Drying Devices: Hot Air Oven, Microwave Oven, Descicators, Vacuum descicators
   e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

(The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal.

2. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error.
   (The learner is expected to know the role of the various reagents/chemicals used In the estimation, various steps involved. They should write the complete and Balanced chemical reaction for the formation of the $Ni(DMG)_2$ complex.
3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error.
   (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).
4. Determination of buffer capacity of acid buffer and basic buffer.
   (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)
5. Estimation of Aspirin
6. Gravimetric estimation of barium ions using K_2CrO_4 as precipitant calculation of % error.
   (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)

Semester IV

Paper III Basics in Analytical Chemistry -II

Theory: 45 Lectures

Unit –I -Methods of separation (15 L)

Objectives:

The learner is expected to understand

- The importance of separation in sample treatment
- Various methods of separations
- How to select a method of separation of an analyte from the matrix
- How a solute gets distributed between two immiscible phases
- Principle of solvent extraction and various terms involved therein
- Effect of various parameters on solvent extraction of a solute
- Classification of Chromatographic methods
- Paper and thin layer chromatography and using them in practice.

1. Separation Techniques in Analytical Chemistry (02 L)

1.1. An Introduction to Analytical Separations and its importance in analysis.

1.2. Estimation of an analyte without effecting separation.

1.3. Types of separation methods

1.3.1. Based on Solubilities (Precipitation, Filtration Crystallisation)

1.3.2. Based on Gravity- Centrifugation

1.3.3. Based on volatility-Distillation ;

1.3.4. Based on Electrical effects-Electrophoresis
1.3.5. Based on retention capacity of a Stationary Phase -Chromatography;
1.3.6. Based on distribution in two immiscible phases-Solvent Extraction;
1.3.7. Based on capacity to exchange with a resin-Ion Exchange;

1.4. **Electrophoresis:** Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. (02L)

1.5. Solvent extraction (06 L)

1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient.
1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.
1.5.3. Single step and multi step extraction, Percentage extraction for single step and multistep extraction. Separation factor.
1.5.4. Batch and continuous extraction

1.6. Chromatography : **(05L)**

1.6.1. Introduction to Chromatography
1.6.2. Classification of chromatographic methods based on stationary and mobile phase
1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.
1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction .

References :

1. D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch – Fundamentals of Analytical chemistry, 8th edition
2. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry
3. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987
4. Modern Analytical Chemistry , David Harvey (page numbers 596 -606)
5. Modern Analytical Chemistry , David Harvey (page numbers 215 -217)

Unit –II - Instrumental Methods-II (15 L)

Objectives
On completing this unit the learner is

- Expected to appreciate the nature of interaction between applied electrical potential and the concentration of the analyte.
- The nature of chemical reactions that influence potential of a given cell.
- Familiar with the various types of electrodes or half cells.
- Appreciate the nature, need and importance of pH
- Expected to know the applications of the various instrumental methods dealt with in this unit.

2. Instruments based on the electrochemical properties of the analytes

2.1. Potentiometry: **(05 L)**

2.1.1. Principle.
2.1.2. Role of Reference and indicator electrodes

2.1.3. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode)

2.1.4. Graphical methods for detection of end points

2.2. pHmetry: **(04 L)**

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Strtong acid-Strong Base) biological and environmental analysis.

2.3. Conductometry: **(06 L)**

2.3.1. Principle

2.3.2. Conductivity cell its construction and care

2.3.3. Applications in Neutralisation Titrimetry with respect to

i. Strong Acid-Strong Base
ii. Strong Acid-Weak Base
iii. Strong Base-weak Acid
iv. Weak Acid- Weak Base**.**

2.3.4. Advantages & limitations of conductometric titrations.

References:

1) Principles of Instrumental analysis, D. A. Skoog, 3rd edition, Saunders college publishing. Chapters: 20, 23 Page nos: 600 - 605, 631, 704 - 711.
2) Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman. Chapters: XIV, XV Page nos: 566 - 601, 615 – 625.
3) Instrumental methods of analysis, B. K. Sharma, Goel publishing house. Miscellaneous methods: Chapters: 1, 3, 4 Page nos: 1 - 14, 21 - 57.

Unit III- Statistical Treatment of analytical data --II (15 L)

Objectives:

On completing this unit the learner is expected to understand

i) The use of statistical methods in chemical analysis.
ii) The nature of indeterminate errors
iii) The randomness of such errors and its distribution around a correct or acceptable result
iv) Computation of Confidence limits and confidence interval
v) Test for rejection of doubtful result
vi) Method to draw best fitting straight line

3.1.**Nature of Indeterminate Errors: (03L)**

3.1.1. The true and acceptable value of a result of analysis

3.1.2. Measures of central tendency: mean, median. mode, average

3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s,sigma) variance, coefficient of variation

3.2.**Distribution of random errors: (02L)**

3.2.1. Gaussian distribution curve.

3.2.2. Equation and salient features of Gaussian distribution curve

3.3.Concept of Confidence limits and confidence interval and its computation using (03 L)

(i) Population standard deviation

(ii) Student's *t* test

(iii) Range

3.4.Criteria for rejection of doubtful result (02 L)

(i) 2.5 d rule

(ii) 4.0 d rule

(iii) Q test

3.5.Test of Significance (02 L)

(i) Null hypothesis

(ii) F-test (variance ratio test)

3.6. Graphical representation of data and obtaining best fitting straight line (03 L)

(a) For line passing through origin

(b) For line not passing through origin

[Numerical problems wherever possible, expected]

References:

1. Modern Analytical Chemistry , David Harvey (page numbers 53 -84)
2. Fundamentals of analytical chemistry – Skoog and West

Semester IV
Chemistry Practicals:
Paper III Elective
(Basics in analytical Chemistry)

1. Tools of Analytical Chemistry-II

a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.

b. Development chamber for chromatography

c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)

d. Conductivity cell (with respect to care and maintenance.)

e. Combined Glass electrode (with respect to care and maintenance.)

f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2. **Paper chromatography:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample.

3. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions.
   (The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)
4. Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results).
5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results).
6. Gravimetric estimation of Sulfate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)
   (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

REFERENCES:

***F*or paper III**

1. **D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.**
2. **A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).**
3. **R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).**
4. **Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi**

T.Y.B.Sc. CHEMISTRY (6 UNITS)

Choice Based Credit System

SEMESTER V

ANALYTICAL CHEMISTRY

COURSE CODE: USCH504 CREDITS: 02 LECTURES: 60

UNIT I :INTRODUCTION TO QUALITY CONCEPTS,CHEMICAL CALCULATIONS AND SAMPLING (3 & 6 UNITS)			
1.1	**Quality in Analytical Chemistry**		**05 L**
	1.1.1	Concepts of Quality, Quality Control and Quality Assurance	
	1.1.2	Importance of Quality concepts in Industry	
	1.1.3	Chemical Standards and Certified Reference Materials; Importance in chemical analysis Quality of material: Various grades of laboratory reagents	
1.2	**Chemical Calculations (Numericals and word problems are expected)**		**04 L**
	1.2.1	Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples)	
	1.2.2	Percent composition of elements in chemical compounds	
1.3	**Sampling**		**06 L**
	1.3.1	Purpose, significance and difficulties encountered in sampling	
	1.3.2	Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of sampling of compact solids, sampling of particulate solids, methods and equipments used for sampling of particulate solids.	
	1.3.3	Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids.	
	1.3.4	Sampling of gases: Ambient and stack sampling: Apparatus and	

		methods for sampling of gases.	
	1.3.5	Collection, preservation and dissolution of the sample.	
UNIT II : CLASSICAL METHODS OF ANALYSIS (TITRIMETRY) (3 & 6 UNITS)			
2.1	**Redox Titrations (Numerical and word Problems are expected)**		**08 L**
	2.1.1	Introduction	
	2.1.2	Construction of the titration curves and calculation of E_{system} in aqueous medium in case of: (1) One electron system (2) Multielectron system	
	2.1.3	Theory of redox indicators, Criteria for selection of an indicator Use of diphenyl amine and ferroin as redox indicators	
2.2	**Complexometric Titrations**		**07 L**
	2.2.1	Introduction, construction of titration curve	
	2.2.2	Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant.	
	2.2.3	Types of EDTA titrations.	
	2.2.4	Metallochromic indicators, theory, examples and applications	
UNIT III: OPTICAL METHODS(6 UNITS)			
3.1	**Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS)**		**07 L**
	3.1.1	Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra	
	3.1.2	Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors)	
	3.1.3	Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser)	
	3.1.4	Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method.	

	3.1.5	Comparison between FES and AAS	
	3.1.6	Applications, Advantages and Limitations	
3.2	**Molecular Fluorescence and Phosphorescence Spectroscopy**		**04L**
	3.2.1	Introduction and Principle	
	3.2.2	Relationship of Fluorescence intensity with concentration	
	3.2.3	Factors affecting Fluorescence and Phosphorescence	
	3.2.4	Instrumentation and applications	
	3.2.5	Comparison of Fluorimetry and Phosphorimetry	
	3.2.6	Comparison with Absorption methods	
3.3	**Turbidimetry and Nephelometry**		**04 L**
	3.3.1	Introduction and Principle	
	3.3.2	Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index	
	3.3.3	Instrumentation and Applications	
UNIT IV: METHODS OF SEPARATION – I (6 UNITS)			
4.1	**Solvent Extraction**		**06 L**
	4.1.1	Factors affecting extraction: Chelation, Ion pair formation and Solvation	
	4.1.2	Graph of percent extraction versus pH. Concept of $[pH]_{1/2}$ and its significance (derivation not expected)	
	4.1.3	Craig's counter current extraction: Principle, apparatus and applications	
	4.1.4	Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis.	
	4.1.5	Comparison of solid phase extraction and solvent extraction.	
4.2	**High Performance Liquid chromatography (HPLC)**		**06L**
	4.2.1	Introduction and Principle Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn, Sample injection system, HPLC Columns, Detectors(UV – Visible detector, Refractive index detector)	
	4.2.2	Qualitative and Quantitative Applications of HPLC	

4.3	**High Performance Thin Layer Chromatography (HPTLC)**		**03 L**
	4.3.1	Introduction and Principle Stationary phase, Sample application and mobile phase	
	4.3.2	Detectors a) Scanning densitometer- Components. Types of densitometer- Single beam and Double beam b) Fluorometric Detector	
	4.3.3	Advantages, disadvantages and applications	
	4.3.4	Comparison of TLC and HPTLC	

REFERENCES

1.	3000 solved problems in Chemistry, David E. Goldberg,PhD.,Schaums Outline	Unit/s: (1.2)
2.	A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002),	Unit/s (1.1)
3.	A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001)	Unit/s (1.3)
4.	Analytical Chemistry, Gary.D Christan, 5th edition	Unit/s (4.1,4.2,4.3)
5.	Analytical Chemistry Skoog, West ,Holler,7th Edition:	Unit/s (2.1)
6.	Analytical Chromatography, Gurdeep R Chatwal, Himalaya publication	Unit/s (4.1,4.2,4.3)
7.	Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p) Limited	Unit/s (4.1,4.2,4.3)
8.	Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969	Unit/s (4.1,4.2,4.3)
9.	Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition	Unit/s (4.1,4.2,4.3)
10.	Handbook of quality assurance for the analytical chemistry laboratory, 2ndEdn., James P. DuxVanNostr and Reinhold, 1990	Unit/s (1.1)
11.	High Performance Thin Layer Chromatography by Dr P.D. Sethi, CBS Publisher and Distribution	Unit/s(4.1,4.2,4.3)

12.	High Performance Thin Layer Chromatography in Food analysis, by Prem kumar, CBS Publisher and distributer	Unit/s (4.1,4.2,4.3)
13.	Instrumental methods of Analysis, by Dr Supriya S Mahajan, Popular Prakashan Ltd	Unit/s (4.1,4.2,4.3)
14.	Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd	Unit/s (3.1,3.2,3.3)
15.	Instrumental Methods of Chemical Analysis by B.K. Sharma Goel Publishing House	Unit/s (4.1,4.2,4.3)
16.	Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman	Unit/s (4.1,4.2,4.3)(3.1,3.2,3.3)
17.	Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)	Unit/s (1.1)
18.	Quality in the Analytical Chemistry Laboratory, Elizabeth Prichard, Neil T. Crosby, Florence Elizabeth Prichard, John Wiley and Sons, 1995	Unit/s (1.1)
19.	Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969	Unit/s (4.1,4.2,4.3)
20. .	Thin Layer Chromatography, A LAB. Handbook, Egon Stahl, Springer International Student Edition	Unit/s (4.1,4.2,4.3)

PRACTICALS

SEMESTER V

ANALYTICAL CHEMISTRY

COURSE CODE: USCHP13 **CREDITS: 02**

1. Spectrophotometric estimation of fluoride
2. Estimation of magnesium content in Talcum powder by complexometry, using standardized solution of EDTA
3. Determination of COD of water sample.
4. To determine potassium content of a Fertilizer by Flame Photometry (Calibration curve method).
5. To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution.
6. To determine the amount of sulphate in given water sample turbidimetrically.

Note: Calculation of percent error is expected for all the experiments.

REFERENCES

1.	Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2.	Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al

SEMESTER VI

ANALYTICAL CHEMISTRY

COURSE CODE: USCH604 CREDITS: 02 LECTURES: 60

UNIT I: ELECTRO ANALYTICAL TECHNIQUES(3 & 6 UNITS)			
1.1	**Polarography** (**Numerical and word problems are expected)**		**11L**
	1.1.1	Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes	
	1.1.2	Basic principle of polarography H shaped polarographic cell, DME (construction, working, advantages and limitations)	
	1.1.3	DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors Qualitative aspects of Polarography: Half wave potential $E_{1/2}$, Factors affecting $E_{1/2}$ Quantitative aspects of polarography: Ilkovic equations: various terms involved in it (No derivation)	
	1.1.4	Quantification 1) Wave height – Concentration plots (working plots/calibration) 2) Internal standard (pilot ion) method 3) Standard addition method	
	1.1.5	Applications advantages and limitations	
1.2	**Amperometric Titrations**		**04L**
	1.2.1	Principle, Rotating Platinum Electrode(Construction, advantages and limitations)	
	1.2.2	Titration curves with example	
	1.2.3	Advantages and limitations	

UNIT II: METHODS OF SEPARATION - II (3 & 6 UNITS)			
2.1	**Gas Chromatography** (**Numerical and word problems are expected**)		**09 L**
	2.1.1	Introduction, Principle, Theory and terms involved	
	2.1.2	Instrumentation: Block diagram and components,types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD	
	2.1.3	Qualitative, Quantitative analysis and applications	
	2.1.4	Comparison between GSC and GLC	
2.2	**Ion Exchange Chromatography**		**06 L**
	2.2.1	Introduction, Principle.	
	2.2.2	Types of Ion Exchangers , Ideal properties of resin	
	2.2.3	Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor Factors affecting separation of ions	
	2.2.4	Ion exchange capacity and its determination for cation and anion exchangers.	
	2.2.5	Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids	
UNIT III:FOOD AND COSMETICS ANALYSIS(6 UNITS)			
3.1	**Introduction to food chemistry**		**10 L**
	3.1.1	Food processing and preservation: Introduction, need, chemical methods, action of chemicals(sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control Physical methods (Pasteurization and Irradiation)	
	3.1.2	Determination of boric acid by titrimetry and sodium benzoate by HPLC.	
	3.1.3	Study and analysis of food products and detection of adulterants **1)** Milk: Composition & nutrients, types of milk (fat free, organic and lactose milk) Analysis of milk for lactose by Lane Eynon's Method	

		2) Honey: Composition Analysis of reducing sugars in honey by Coles Ferricyanide method **3)** Tea: Composition, types (green tea and mixed tea) Analysis of Tannin by Lowenthal's method **4)** Coffee: Constituents and composition, Role of Chicory Analysis of caffeine by Bailey Andrew method	
3.2	**Cosmetics**		**05 L**
	3.2.1	Introduction and sensory properties	
	3.2.2	Study of cosmetic products – **1)** Face powder: Composition Estimation of calcium and magnesium by complexometric titration **2)** Lipstick: Constituents Ash analysis for water soluble salts: borates, carbonates and zinc oxide **3)** Deodorants and Antiperspirants: Constituents, properties Estimation of zinc by gravimetry	
UNIT IV:THERMAL METHODS AND ANALYTICAL METHOD VALIDATION (6 UNITS)			
4.1	**Thermal Methods**		**12 L**
	4.1.1	Introduction to various thermal methods (TGA, DTA and Thermometric titration)	

	4.1.2	**Thermogravimetric Analysis(TGA)** Instrumentation-block diagram,thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) Thermogram (TG curve)for$CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Factors affecting thermogram-Instrumental factors and Sample characteristics Applications: Determination of drying and ignition temperature range Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate)	
	4.1.3	**Differential Thermal Analysis (DTA):** Principle**,** Instrumentation, and Reference material used	
		Differential thermogram (DTA curve) $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$	
		Applications Comparison between TGA and DTA.	
	4.1.4	**Thermometric Titrations –** Principle and Instrumentation Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium Tartarate**.**	
4.2	**Analytical Method Validation**		**03L**
	4.2.1	Introduction and need for validation of a method	
	4.2.2	Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness	

Note: Concept of sensitivity is to be discussed for all techniques and instruments mentioned in the syllabus.

REFERENCES

1.	An Advance Dairy chemistry, V 3, P. F. Fox, P. L. H. McSweeney Springer	Unit/s (3.1,3.2)

2.	Analysis of food and Beverages, George Charalanbous, Academic press 1978	Unit/s (3.1,3.2)
3.	Analytical Chemistry of Open Learning(ACOL),James W. Dodd & Kenneth H. Tonge	Unit/s (4.1,4.2)
4.	Analytical chemistry David Harvey The ,McGraw Hill Companies, Inc.	Unit/s (4.1,4.2)
5.	Analytical Chemistry, Gary.D Christan, 5th edition	Unit/s (2.1,2.2)
6.	Analytical chemistry, R. K. Dave.	Unit/s (2.1,2.2)
7.	Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969	Unit/s (2.1,2.2)
8.	Egyankosh.ac.in/bitstream/123456789/43329/1/Unit-8	Unit/s (1.1,1.2,1.3)
9.	Food Analysis, Edited by S. Suzanne Nielsen, Springer	Unit/s (3.1,3.2)
10.	Food Analysis: Theory and practice, YeshajahuPomeranz, Clifton E. Meloan, Springer	Unit/s (3.1,3.2)
11.	Formulation and Function of cosmetics, Sa Jellineck	Unit/s (3.1,3.2)
12.	Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt., Saunders 6th Edition (1992)	Unit/s (2.1,2.2)
13.	Government of India publications of food drug cosmetic act and rules.	Unit/s (3.1,3.2)
14.	Harry's Cosmetology, Longman scientific co.	Unit/s (3.1,3.2)
15.	High Performance Thin Layer Chromatography in Food analysis, by Prem kumar, CBS Publisher and distributer	Unit/s (3.1,3.2)
16.	Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd	Unit/s (1.1,1.2,1.3) (4.1,4.2,4.3)
17.	Introduction to Polarography and Allied Techniques, By Kamala Zutshi, New Age International, 2006.	Unit/s (1.1,1.2,1.3)
18.	Modern cosmetics, E. Thomessen Wiley Inter science	Unit/s (3.1,3.2)

19.	Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman	Unit/s (4.1,4.2,4.3)
20.	Principles of Polarography by Jaroslav Heyrovský , Jaroslav Kůta, 1st Edition, Academic Press, eBook ISBN: 978148326478	Unit/s (1.1,1.2,1.3)
21.	Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969	Unit/s (2.1,2.2,)

PRACTICALS

SEMESTER VI

ANALYTICAL CHEMISTRY

COURSE CODE: USCHP14 **CREDITS: 02**

1 Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide.

2 Estimation of reducing sugar in honey by Willstatter method.

3 Estimation o Mg^{+2} & Zn^{+2} by anion exchange resin.
using an anion exchange resin

4 Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically.

5 Determination of phosphoric acid in cola sample pH metrically.

Note: Calculation of percent error is expected for all the experiments.

References:

1.	Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).

2.	Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al
3.	The chemical analysis of food and food products III edition Morris Jacob
4.	The chemical analysis of food by David Pearson and Henry Edward

T.Y.B.Sc. CHEMISTRY (6 UNITS)

Choice Based Credit System

SEMESTER V

INORGANIC CHEMISTRY

COURSE CODE: USCH502 CREDITS: 02 LECTURES: 60

UNIT-I	L/Week
1. Molecular Symmetry and Chemical Bonding	
1.1Molecular Symmetry (6L)	
1.1.1 Introduction and Importance of Symmetry in Chemistry.	
1.1.2 Symmetry elements and Symmetry operations.	
1.1.3 Concept of a Point Group with illustrations using the following point groups :(i)$C_{\infty V}$ (ii) $D_{\infty h}$ (iii) C_{2V} (iv) C_{3v} (v)C_{2h} and (vi)D_{3h}	
1.2 Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species (9L)	
1.2.1 Comparision between homonuclear and heteronuclear diatomic molecules.	
1.2.2. Heteronuclear diatomic molecules like CO, NO and HCl, appreciation of modified MO diagram for CO.	
1.2.3 Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected).	
1.2.4. Molecular shape to molecular orbital approach in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only. (Examples like : i) BeH_2, ii) H_2O).	
UNIT-II	
2 SOLID STATE CHEMISTRY	
2.1 Structures of Solids (11L)	
2.2.1 Explanation of terms viz.crystal lattice, lattice point, unit cell and lattice constants.	
2.1.2 Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters.	

2.1.3 Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected).	
2.2 Superconductivity (4L)	
2.2.1 Discovery of superconductivity.	
2.2.2 Explanation of terms like superconductivity, transition temperature, Meissner effect.	
2.2.3 Different types of super conductors viz.conventional superconductors, alkali metal fullerides, high temperature super conductors.	
2.2.4 Brief application of superconductors.	
UNIT-III	
3.0 CHEMISTRY OF INNER TRANSITION ELEMENTS (15L)	
3.1 Introduction: Position in periodic table and electronic configuration of lanthanides and actinides.	
3.2 Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences(ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties	
3.3 : Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique)	
3.4 Applications of lanthanides	
UNIT-IV	
4. SOME SELECTED TOPICS	
4.1 Chemistry of Non-aqueous Solvents (5 L)	
4.1.1Classification of solvents and importance of non-aqueous solvents.	
4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to : (i) acid-base reactions and (ii) redox reactions.	
4.2 Comparative Chemistry of Group 16 (5L)	
4.2.1 Electronic configurations, trends in physical properties, allotropy	
4.2.2 Manufacture of sulphuric acid by Contact process.	
4.3 Comparative Chemistry of Group 17 (5L)	
4.3.1Electronic configuration , General characteristics, anamolous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidising properties and structures(on the basis of VSEPR theory)	
4.3.2 Chemistry of interhalogens with reference to preparations, properties and structures (on the basis of VSEPR theory) .	

REFERENCES

SEM-V

Unit-I

1. Per Jensen and Philip R. Bunker , Fundamentals of Molecular Symmetry , Series in Chemical Physics, Taylor & Francis Group
2. J. S. Ogden, Introduction to Molecular Symmetry, Oxford University Press
3. Derek W. Smith, Molecular orbital theory in inorganic chemistry Publisher: Cambridge University Press
4. C. J. Ballhausen, Carl Johan Ballhausen, Harry B. Gray Molecular Orbital Theory: An Introductory Lecture Note and Reprint Volume Frontiers in chemistry Publisher W.A. Benjamin, 1965
5. Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East west Press Pvt. Ltd., New Delhi.
6. Satya Prakash, G.D.Tuli, R.D. Madan , , Advanced Inorganic Chemistry.S. Chand & Co Ltd

Unit-II

1. Lesley E. Smart, Elaine A. Moore Solid State Chemistry: An Introduction, 2nd Edition CRC Press,
2. C. N. R. Rao Advances in Solid State Chemistry
3. R.G. Sharma Superconductivity: Basics and Applications to Magnets
4. Michael Tinkham ,Introduction to Superconductivity: Vol I (Dover Books on Physics)
5. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
6. Richard Harwood, Chemistry, Cambridge University Press,
7. Satya Prakash, G.D.Tuli, R.D. Madan , , Advanced Inorganic Chemistry.S. Chand & Co Ltd .

Unit-III

1. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
2. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
3. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
4. G. Singh, Chemistry of Lanthanides and Actinides, Discovery Publishing House
5. Simon Cotton , Lanthanide and Actinide Chemistry Publisher: Wiley-Blackwell

Unit-IV

1. B. H. Mahan, University Chemistry, Narosa publishing.

2. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
3. J. D. Lee, Concise Inorganic Chemistry, 4thEdn., ELBS,
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press
5. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
6. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,.Ltd. (2002).
7. Richard Harwood, Chemistry, chapter 10 Industrial inorganic chemistry
8. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
9. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993
10. Satya Prakash, G.D.Tuli, R.D. Madan , Advanced Inorganic Chemistry.S. Chand & Co Ltd 2004

Practicals

SEMESTER V

INORGANIC CHEMISTRY

COURSE CODE: USCHP05 **CREDITS: 02**

Course USCH502: Inorganic Practicals (60L)

I. Inorganic preparations

1. Preparation of Potassium diaquobis- (oxalato)cuprate (II)
2. Preparation of Ferrous ethylene diammonium sulphate.
3. Preparation of bisacetylacetonatocopper(II)

II. Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests).

(Any three salts of transition metal ions)

Reference Books (practicals)

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.

2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur & Sons Pvt Ltd .
3. Vogel's. Textbook of. Macro and Semimicro qualitative inorganic analysis. Fifth edition.

SEMESTER VI

INORGANIC CHEMISTRY

COURSE CODE: USCH602 CREDITS: 02 LECTURES: 60

COURSE CODE	**CREDITS**
USCH602	**(60 Lectures)**
(Numericals and word problems are expected)	
UNIT-I	**L/week**
1.Theories of the metal-ligand bond (I) (15L)	
1.1 Limitations of Valence Bond Theory.	
1.2 Crystal Field Theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral(from coordination number 2 to coordination number 6)	
1.3 Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields.	
1.4 Distortions from the octahedral geometry : (i) effect of ligand field and (ii) Jahn-Teller distortions.	
1.5 Crystal field splitting parameters Δ ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series.	
1.6 Crystal field stabilization energy(CFSE), calculation of CFSE for octahedral complexes with d^0 to d^{10} metal ion configurations.	
1.7 Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series.	
1.8 Limitations of CFT : Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of $[IrCl_6]^{2-}$ (iii) Nephelauxetic effect.	
UNIT-II	
2.Theories of the metal-ligand bond (II)	
2.1 Molecular orbital Theory for coordination compounds. (4L)	

2.1.1 Identification of the central metal orbitals and their symmetry suitable for formation of σ bonds with ligand orbitals.	
2.1.2 Construction of ligand group orbitals.	
2.1.3 Construction of σ-molecular orbitals for an ML_6 complex.	
2.1.4 Effect of π-bonding on complexes .	
2.1.5 Examples like $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$, $[FeF_6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3}$, $[Co(NH_3)_6]^{+3}$	
2.2 Stability of Metal-Complexes (4L)	
2.2.1 Thermodynamic and kinetic perspectives of metal complexes with examples.	
2.2.2 Stability constants: stepwise and overall stability constants and their interrelationship.	
2.2.3 Factors affecting thermodynamic stability.	
2.3 Reactivity of metal complexes. (4L)	
2.3.1 Comparison between Inorganic and organic reactions.	
2.3.2 Types of reactions in metal complexes.	
2.3.3 Inert and labile complexes : correlation between electronic configurations and lability of complexes.	
2.3.4 Ligand substitution reactions : Associative and Dissociative mechanisms.	
2.2.5 Acid hydrolysis, base hydrolysis and anation reactions.	
2.4 Electronic Spectra. (3L)	
2.4.1Origin of electronic spectra	
2.4.2 Types of electronic transitions in coordination compounds: intra- ligand,Charge transfer and intra-metal transitions.	
2.4.3 Selection rules for electronic transitions.	
2.4.4 Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions, rules for determination of ground state term.	
2.4.5 Determination of Terms for p^2 and d^1 electronic configurations.	
UNIT-III	
3 ORGANOMETALLIC CHEMISTRY (15L)	
3.1 Organometallic Compounds of main group metal (6L)	
3.1.1General characteristics of various types of organometallic compounds, viz.ionic, σ-bonded and electron deficient compounds.	
3.1.2 General synthetic methods of organometallic compounds : (i) Oxidative-addition, (ii)Metal-metal exchange(transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange(metallation) and (v) Methylene-insertion reactions.	
3.1.3 Some chemical reactions of organometallic compounds:	

(i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents, (iv) Redistribution reactions and (v) Complex formation reactions.	
3.2 Metallocenes (5L)	
Introduction, Ferrocene : Synthesis, properties, structure and bonding on the basis of VBT.	
3.3 Catalysis (4L)	
3.3.1 Comparison between homogeneous and heterogeneous catalysis	
3.3.2 Basic steps involved in homogeneous catalysis	
3.3.3 Mechanism of Wilkinson's catalyst in hydrogenation of alkenes.	
UNIT-IV	
4 SOME SELECTED TOPICS (15L)	
4.1 Metallurgy (7L)	
4.1.1 Types of metallurgies,	
4.1.2 General steps of metallurgy; Concentration of ore, calcinations, roasting,reduction and refining.	
4.1.3 Metallurgy of copper: occurrence, physicochemical principles, Extraction of copper from pyrites& refining by electrolysis.	
4.2 Chemistry of Group 18 (5L)	
4.2.1 Historical perspectives	
4.2.2 General characteristics and trends in physical and chemical properties	
4.2.3 Isolation of noble gases	
4.2.4 Compounds of Xenon (oxides and fluorides) with respect to preparation and structure (VSEPR)	
4.2.5 Uses of noble gases	
4.3 Introduction to Bioinorganic Chemistry. (3L)	
4.3.1Essential and non essential elements in biological systems.	
4.3.2 Biological importance of metal ions such as Na^{+},K^{+},Fe^{+2}/Fe^{+3} and Cu^{+2}(Role of Na^{+} and K^{+} w.r.t ion pump)	

References.

SEM-VI

Unit-I:

1. Geoffrey A. Lawrance Introduction to Coordination Chemistry John Wiley & Sons.
2. R. K. Sharma Text Book of Coordination Chemistry Discovery Publishing House
3. R. Gopalan , V. Ramalingam Concise Coordination Chemistry , Vikas Publishing House;
4. Shukla P R, Advance Coordination Chemistry , Himalaya Publishing House
5. Glen E. Rodgers, Descriptive Inorganic, Coordination, and Solid-State Chemistry Publisher: Thomson Brooks/Cole

Unit-II:

1. Ramesh Kapoor and R.S. Chopra, **Inorganic Chemistry**, R. Chand publishers,
2. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY,
3. Twigg ,Mechanisms of Inorganic and Organometallic Reactions Publisher: Springer
4 R.K. Sharma Inorganic Reaction Mechanisms Discovery Publishing House
5 M. L. Tobe Inorganic Reaction Mechanisms Publisher Nelson, 1972

Unit-III:

1 Cotton, Wilkinson, Murillo and Bochmann, Advanced **Inorganic Chemistry**, 6th Edition..
2 H.W. Porterfield, Inorganic Chemistry, Second Edition, Academic Press, 2005
3 Purecell, K.F. and Kotz, J.C., Inorganic Chemistry W.B. Saunders Co. 1977.
4 Robert H. Crabtree ,The Organometallic Chemistry of the Transition Metals, Publication by John Wiley & Sons
5 B D Gupta & Anil J Elias Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University press
6 Ram Charan Mehrotra, Organometallic Chemistry: A Unified Approach, New Age International.

Unit-IV

1 R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
2 D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press
3 Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
4 Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East west Press Pvt. Ltd., New Delhi.
5 R.Gopalan, Chemistry for undergraduates. Chapter 18. Principles of Metallurgy.(567-591)
6 Puri ,Sharma Kalia Inorganic chemistry. Chapter 10, Metals and metallurgy.(328-339)

7 Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
8 Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
9 Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
10 Satya Prakash, G.D.Tuli, R.D. Madan , , Advanced Inorganic Chemistry.S. Chand & Co Ltd

PRACTICALS

SEMESTER VI

INORGANIC CHEMISTRY

COURSE CODE: USCHP06 **CREDITS: 02**

I. Inorganic preparations

1. Preparation of Tris(acetylacetonato) iron(III)
2. Green synthesis of bis(dimethylglyoximato) nickel(II) complex using nickel carbonate and sodium salt of dmg .
3. Preparation of potassium trioxalato aluminate (III)

II. Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests).

(Any three salts of main group metal ions)

Reference Books (practicals)

4. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
5. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur & Sons Pvt Ltd .
6. Vogel's. Textbook of. Macro and Semimicro qualitative inorganic analysis. Fifth edition.

UNIVERSITY OF MUMBAI

No. UG/73of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular Nos. UG/156 of 2016-17, dated 16th November, 2016 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Chemistry at its meeting held on 28th May, 2018 have been accepted by the Academic Council at its meeting held on 14th June, 2018 **vide** item No. 4.41 and that in accordance therewith, the revised syllabus as per the (CBCS) for the Chemistry of T.Y.B.Sc. Physical Chemistry, Inorganic Chemistry, Organic Chemistry and Analytical Chemistry (Sem - V & VI) (3 and 6 Units) including Applied Component Drugs and Dyes, Heavy Fine Chemicals and Petrochemicals has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
6th ~~June~~ July, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C./4.41/14/06/2018

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No. UG/ 73 -A of 2018 MUMBAI-400 032 6th ~~June~~ July, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Chemistry,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

T.Y.B.Sc, CHEMISTRY (Six Units)

SEMESTER V

ORGANIC CHEMISTRY

COURSE CODE: USCH503 **CREDITS: 02** **LECTURES: 60**

Unit I

1.1 Mechanism of organic reactions (10 L)

1.1.1 The basic terms & concepts: bond fission, reaction intermediates, electrophiles & nucleophiles, ligand, base, electrophilicity vs. acidity & nucleophilicity vs basicity.

1.1.2 Neighbouring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome.

1.1.3 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification of carboxylic acids ($A_{AC}2$) and base promoted hydrolysis of esters ($B_{AC}2$).

1.1.4 Pericyclic reactions, classification and nomenclature

1.1.4.1 Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type)

1.1.4.2 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates

References:

1. A guidebook to mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson education, New Delhi
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluwalia, R. K. Parashar, Narosa Publication.
3. Organic reactions & their mechanisms,3rd revised edition, P.S. Kalsi, New Age International Publishers.
4. M.B.Smith and J. March, Advanced organic chemistry- reactions mechanism and structure, 5th edition.

1.2 Photochemistry (5 L)

1.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization.

1.2.2 Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4-dienes (di- π methane)

1.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzpinacol)

References:

1. Organic Chemistry, 7th Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
2. Organic chemistry,8th edition, John Mc Murry

Unit II

2.1 Stereochemistry I (5 L)

2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, roation -reflection (alternating) axis.

2.1.2 Chirality of compounds without a stereo genic center: cummulenes and biphenyls.

References:

1. L. Eliel , stereochemistry of carbon compounds, Tata McGraw Hill
2. Stereochemistry P.S.Kalsi , New Age International Ltd.,4th Edition
3. Stereochemistry by Nassipuri.

2.2 Agrochemicals (4 L)

2.2.1 General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators.

2.2.2 Advantages & disadvantages of agrochemicals

2.2.3 Synthesis & application of IAA (Indole Acetic Acid) & Endosulphan,

2.2.4 Bio pesticides – Neem oil & Karanj oil.

References:

1. Insecticides & pesticides: Saxena A. B., Anmol publication.
2. Growth regulators in Agriculture & Horticulture: Amarjit Basra, CRC press 2000.
3. Agrochemicals and pesticides: A.Jadhav and T.V.Sathe.

2.3 Heterocyclic chemistry: (6 L)

2.3.1 Reactivity of pyridine-N-oxide, quinoline and iso-quionoline.

2.3.2 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler-Napieralski synthesis).

2.3.3 Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3, n-BuLi.

2.3.4 Reactions of quinoline and isoquinoline; oxidation,reduction,nitration,halogenation and reaction with $NaNH_2$/liq.NH_3,n-BuLi.

References

1. Name Reactions in Heterocyclic Chemistry, Jie-Jack Li, Wiley-Interscience publications, 2005.
2. Handbook of Heterocyclic Chemistry, 2nd Edition, Alan R. Katritzky and Alexander F. Pozharskii, Elsevier Science Ltd, 2000.
3. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mills, Wiley publication, 2010.
4. Heterocyclic chemistry, 3rd Edition, Thomas L. Gilchrist, Pearson Education, 2007.

Unit III

3.1 IUPAC (5 L)

IUPAC Systematic nomenclature of the following classes of compounds (including compounds upto two substituents / functional groups):

3.1.1 Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds.

3.1.2 Biphenyls

3.1.3 Cummulenes with upto 3 double bonds

3.1.4 Quinolines and isoquinolines

References

1. Nomenclature of Organic Chemistry**:** IUPAC recommendations and preferred Names 2013, RSC publication.
2. IUPAC nomenclature by S.C.Pal.

3.2 Synthesis of organic compounds (10L)

3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and regioselectivity with examples, calculation of yields.

3.2.2 Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples (no mechanism)

3.2.3 Green chemistry and synthesis:

Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples.

i) Green reagents: dimethyl carbonate.
ii) Green starting materials : D-glucose
iii) Green solvents : supercritical CO_2
iv) Green catalysts: Bio catalysts.

3.2.4 Planning of organic synthesis

i) synthesis of nitroanilines. (*o&p*)
ii) synthesis of halobenzoic acid.(*o&p*)
iii) Alcohols (primary / secondary / tertiary) using Grignard reagents.
iv) Alkanes (using organo lithium compounds)

Reference:

1. Green chemistry an introductory text : Mike Lancaster.
2. Green chemistry: V. K. Ahluwalia (Narosa publishing house pvt. ltd.)
3. Green chemistry an introductory text : RSC publishing.
4. New trends in green chemistry V. K. Ahluwalia , M. Kidwai, Klumer Academic publisher
5. Green chemistry by V. Kumar.
6. Organic chemistry: Francis Carey
7. Organic chemistry: Carey and Sundberg.

Unit IV

4.1 Spectroscopy I (5 L)

4.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency

4.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrome interactions.

4.1.3 Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds.

References:

1. Organic spectroscopy (Second edition),Jag Mohan ,Narosa publication
2. Spectroscopy, Pavia, Lampman, Kriz,Vyvyan.

3. Elementary organic spectroscopy (Third edition), Y.R.Sharma, S.Chand publication..
4. Introduction to spectroscopy (third edition), Pavia ,Lampman,Kriz,john vondeling,Emily Barrosse.
5. Organic chemistry Paula Y. Bruice, Pearson education.
6. Spectral identification of organic molecules by Silverstein.
7. Absorption spectroscopy of organic molecules by V.M.Parikh.

4.2 Natural Products: (10L)

4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule.

4.2.2 Citral:

a) Structural determination of citral.
b) Synthesis of citral from methyl heptenone
c) Isomerism in citral. (cis and trans form).

4.2.3. Alkaloids Introduction and occurrence.

Hofmann's exhaustive methylation and degradation in**:** simple open chain and N – substituted monocyclic amines.

4.2.4 Nicotine:

a) Structural determination of nicotine. (Pinner's work included)
b) Synthesis of nicotine from nicotinic acid
c) Harmful effects of nicotine.

4.2.5 Hormones:

Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline.
Synthesis of adrenaline from

a) Catechol
b) p-hydroxybenzaldehyde(Ott's synthesis)

References:

1. Chemistry of natural products by Chatwal Anand – Vol I and Vol II
2. Chemistry of natural products by O.P. Agarwal
3. Chemistry of natural products by Meenakshi Sivakumar and Sujata Bhat.
4. Organic chemistry by Morrision and Boyd,7th edition.
5. I.L.Finar,Vol-I and Vol-II, 5th edition.

PRACTICALS

SEMESTER V

ORGANIC CHEMISTRY

COURSE CODE: USCHP09 **CREDITS: 02**

A) SEMESTER V: Separation of Binary solid-solid mixture (2.0 gms mixture to be given).

1. Minimum Six mixtures to be completed by the students.
2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols(2-naphthol, 1-naphthol), water insoluble bases

(nitroanilines) , water soluble neutral (thiourea) and water insoluble neutral compounds (anilides , amides, m-DNB, hydrocarbons)

After correct determination of chemical type, the separating reagent should be decided by the student for separation.

4. Follow separation scheme with the bulk sample of binary mixture.

5. After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with m.p..

References:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal.

SEMESTER VI

ORGANIC CHEMISTRY

COURSE CODE: USCH603 **CREDITS: 02** **LECTURES: 60**

Unit I

1.1 Stereochemistry II (10 L)

1.1.1 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces.

1.1.2 Stereochemistry of –

i) Substitution reactions : S_{Ni} (reaction of alcohol with thionyl chloride)

ii) Elimination reactions: E_2–Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane.

iii) Addition reactions to olefins:

a) bromination (electrophilic anti addition)

b) syn hydroxylation with O_sO_4 and $KMnO_4$

c) epoxidation followed by hydrolysis.

References:

Refer Stereochemistry –I (Sem-V, Unit-II)

1.2 Amino acids & Proteins (5 L)

1.2.1 α-Amino acids: General Structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, Gabriel phthalamide synthesis.

1.2.2 Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples Merrifield solid phase polypeptide synthesis. .Protiens:general idea of primary,secondary,tertiary & quaternary structure

References:

1. Biochemistry, 8th Ed., Jeremy Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto Pub. W. H. Freeman Publishers
2. Lehninger Principles of Biochemistry 7th Ed., David Nelson and Michael Cox, Publisher W. H. Freeman
3. Name Reactions – Jie Jack Li, 4th Edition, Springer Pub.

Unit II

2.1 Molecular Rearrangements (5 L)

Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.

2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement.

2.1.2 Migration to the electron deficient nitrogen: Beckmann rearrangement.

2.1.3 Migration involving a carbanion : Favorski rearrangement.

2.1.4 Name reactions: Michael addition, Wittig reaction.

References:

Refer Mechanism of organic reaction (Sem-V, Unit-I)

2.2 Carbohydrates (10 L)

2.2.1 Introduction: classification, reducing and non-reducing sugars, DL notation

2.2.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses)
Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose

2.2.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers.

2.2.4 Mutarotation in D-glucose with mechanism

2.2.5 Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Wohl method (D-glucose to D-arabinose)

2.2.6 Reactions of D-glucose and D-fructose:
(a) Osazone formation (b) reduction: Hi/Ni, $NaBH_4$ (c) oxidation: bromine water, HNO_3, HIO_4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms

2.2.7 Glycosides: general structure

References:

1. Organic chemistry (fourth edition),G,Marc Loudon,Oxford University press.
2. Introduction to Organic Chemistry (Third edition), Andrew Streitwieser, Jr. Clayton H. Heathcock, Macmilan publishing.
3. Organic chemistry fourth edition, Morrision and Boyd.
4. Introduction to Organic chemistry,John McMurry.
5. Organic chemistry volume-1&2 (fifth and sixth edition) IL Finar.

Unit III

3.1 Spectroscopy II (10 L)

3.1.1 IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.

3.1.2 PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and

coupling constant. application of deuterium exchange technique. application of PMR in structure determination.

3.1.3 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected).

Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems).

References:

Refer spectroscopy –I, (Sem-V, Unit-IV)

3.2 Nucleic Acids **(5 L)**

Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.

References:

1. Organic chemistry R.T.Morrison and R.N.Boyd, 6th edition, pearson education
2. S.H.Pine, organic chemistry 4th edition. McGraw Hill

Unit IV

4.1 Polymer **(8 L)**

4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermo plastics and thermosets.

4.1.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses.

4.1.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenol formaldehyde resins.Uses

4.1.4 Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of polymerization using Ziegler Natta catalysts.

4.1.5 Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrene butadiene copolymer.

4.1.6 Additives to polymers: Plasticisers, stabilizers and fillers.

4.1.7 Biodegradable polymers: Classification and uses. polylactic acid structure, properties and use for packaging and medical purposes.

(Note : Identification of monomer in a given polymer & structure of polymer for a given monomer is expected. condition for polymerization is not expected)

References:

1. Polymer chemistry by M.G.Arora, K.Singh.
2. Polymer science – a text book by Ahluwalia and Mishra
3. Introduction to polymer chemistry - R.Seymour, Wiley Interscience.

4.2 Catalysts and Reagents **(7 L)**

Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

4.2.1 Catalysts: Catalysts for hydrogenation:

a. Raney Nickel

b. Pt and PtO_2 (C=C, CN, NO_2, aromatic ring)
c. Pd/C : C=C, COCl→CHO (Rosenmund)
d. Lindlar catalyst: alkynes

d.2.2 Reagents**:**

a. $LiAlH_4$ (reduction of CO, COOR, CN,NO_2)
b. $NaBH_4$ (reduction of CO)
c. SeO_2 (Oxidation of CH_2 alpha to CO)
d. mCPBA (epoxidation of C=C)
e. NBS (allylic and benzylic bromination)

References:

1. Organic chemistry by Francis Carey – McGrawHill .
2. Oranic chemistry by Carey and Sundberg, Part A & B

PRACTICALS

SEMESTER VI

ORGANIC CHEMISTRY

COURSE CODE: USCHP10 **CREDITS: 02**

A) SEMESTER VI: Separation of Binary liquid-liquid and liquid- solid mixture.

1. Minimum Six mixtures to be completed by the students.
2. Components of the liq-liq mixture should include volatile liquids like acetone, methylacetate, ethylacetate, isopropylalcohol, ethyl alcohol, EMK and non volatile liquids like chlorobenzene , bromobenzene, aniline, N,N dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate.
3. Components of the liq- solid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, neutral.
4. A sample of the mixture one ml to be given to the student for detection of the physical type of the mixture.
5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using microscale technique.
6. After separation into component A and component B, the compound to be identified can be decided by examiner.

References:

4. Practical organic chemistry – A. I. Vogel
5. Practical organic chemistry – H.Middleton.
6. Practical organic chemistry – O.P.Aggarwal.

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UNIVERSITY OF MUMBAI

No. UG/73of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular Nos. UG/156 of 2016-17, dated 16th November, 2016 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Chemistry at its meeting held on 28th May, 2018 have been accepted by the Academic Council at its meeting held on 14th June, 2018 **vide** item No. 4.41 and that in accordance therewith, the revised syllabus as per the (CBCS) for the Chemistry of T.Y.B.Sc. Physical Chemistry, Inorganic Chemistry, Organic Chemistry and Analytical Chemistry (Sem - V & VI) (3 and 6 Units) including Applied Component Drugs and Dyes, Heavy Fine Chemicals and Petrochemicals has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
6th ~~June~~ July, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C./4.41/14/06/2018

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No. UG/ 73 -A of 2018 MUMBAI-400 032 6th ~~June~~ July, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Chemistry,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

T.Y.B.Sc. CHEMISTRY (6 UNITS)
Choice Based Semester and Grading System
To be implemented from the Academic year 2018-2019

SEMESTER V

PHYSICAL CHEMISTRY

COURSE CODE: USCH502 CREDITS: 02 LECTURES: 60

UNIT	TOPIC	NO. OF Lectures
UNIT I	1.0 MOLECULAR SPECTROSCOPY	15L
	1.1 **Rotational Spectrum**: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, .Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance and isotopic shift. 1.2 **Vibrational spectrum**: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. 1.3 **Vibrational-Rotational spectrum of diatomic molecule**: energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2. 1.4 **Raman Spectroscopy :** Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.	
UNIT II	2.0 CHEMICAL THERMODYNAMICS	10 L
	2.1.1**Colligative properties:** Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - Static and Dynamic method.	
	2.1.2 **Solutions of Solid in Liquid:** 2.1.2.1 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. 2.1.2.2 Depression in freezing point of a solution, thermodynamic	

	derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method.	
	2.1.3 **Osmotic Pressure :** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis.	
	2.2 CHEMICAL KINETICS	5 L
	2.2.1 **Collision theory of reaction rates** : Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both) 2.2.2 Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	
UNIT III	3.0 NUCLEAR CHEMISTRY	15L
	3.1. **Introduction**: **B**asic terms-radioactive constants (decay constant, half life and average life) and units of radioactivity	
	3.2 **Detection and Measurement of Radioactivity:** Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter.	
	3.3 **Application of use of radioisotopes as Tracers :** chemical reaction mechanism, age determination - dating by C^{14}.	
	3.4 **Nuclear reactions**: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.	
	3.5 **Fission Process :** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor.	
	3.6 **Fusion Process :** Thermonuclear reactions occurring on stellar bodies and earth.	
UNIT IV	4.1 SURFACE CHEMISTRY	6L
	4.1.1 **Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms . Langmuir's adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.	
	4.2 COLLOIDAL STATE	9L
	4.2.1 **Introduction to colloids** - Emulsions, Gels and Sols	
	4.2.2 **Electrical Properties** : Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane	

	Equilibrium.	
	4.2.3 **Colloidal electrolytes :** Introduction, micelle formation,	
	4.2.4 **Surfactants:** Classification and applications of surfactants in detergents and food industry.	

Reference Books :

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.

2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.

3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]

4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.

5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer

6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.

7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.

9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.

10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.

11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007.

12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.

13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011..

14. Chemical Kinetics,K. Laidler, Pearson Education India, 1987.

T.Y.B.Sc Physical Chemistry Practical

SEMESTER V

PHYSICAL CHEMISTRY

COURSE CODE: USCHP01

CREDITS: 02

Non-Instrumental

Colligative properties

To determine the molecular weight of compound by Rast Method

Chemical Kinetics

To determine the order between $K_2S_2O_8$ and KI by fractional change method. **(six units and three units)**

Surface phenomena

To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm.

Instrumental

Potentiometry

To determine the solubility product and solubility of AgCl
potentiometrically using chemical cell.

Conductometry

To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method.

pH-metry

To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point.

Reference books

1. Practical Physical Chemistry 3rd edition
A.M.James and F.E. Prichard , Longman publication

2. Experiments in Physical Chemistry R.C. Das and
B. Behra, Tata Mc Graw Hill

3. Advanced Practical Physical Chemistry J.B.Yadav,
Goel Publishing House

4. Advanced Experimental Chemistry. Vol-I
J.N.Gurtu and R Kapoor, S.Chand and Co.

5. Experimental Physical Chemistry By V.D.Athawale.

6. Senior Practical Physical Chemistry By: B. D. Khosla, V. C. Garg and A. Gulati, R Chand and Co.. 2011

SEMESTER VI

PHYSICAL CHEMISTRY

COURSE CODE: USCH601 CREDITS: 02

LECTURES: 60

UNIT I	1.1 ELECTROCHEMISTRY	7L
	1.1.1 **Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation).	
	1.1.2 **Classification of cells:** Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference	

	(derivations are expected),	
	1.2 APPLIED ELECTROCHEMISTRY	8L
	1.2.1 **Polarization**: concentration polarization and it's elimination	
	1.2.2 **Decomposition Potential and Overvoltage** : Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel's equation for hydrogen overvoltage, experimental determination of over –voltage	
UNIT II	2.0 POLYMERS	15L
	2.1 **Basic terms :** macromolecule, monomer, repeat unit, degree of polymerization.	
	2.2. **Classification of polymers:** Classification based on source, structure, thermal response and physical properties.	
	2.3. **Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity	
	2.4. **Method of determining molar masses of polymers :** Viscosity method using Ostwald Viscometer. (derivation expected)	
	2.5. **Light Emitting Polymers :** Introduction, Characteristics, Method of preparation and applications.	
	2.6. **Antioxidants and Stabilizers :** Antioxidants , Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	
UNIT III	3.1 BASICS OF QUANTUM CHEMISTRY	10 L
	3.1.1 **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.	
	3.1.2 **Quantum mechanics :** Introduction, Planck's theory of quantization, wave particle duality, de –Broglie's equation, Heisenberg's uncertainty principle.	
	3.1.3 **Progressive and standing waves-** Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function.	
	3.1.4 **Quantum mechanics** : State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value.	
	3.2 RENEWABLE ENERGY RESOURCES	5L
	3.2.1. **Renewable energy resources** : Introduction.	
	3.2.2 **Solar energy**: Solar cells, Photovoltaic effect, Differences between conductors,semiconductors ,insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell	
	3.2.3. **Hydrogen :** Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	

UNIT IV	4.1 NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY	7L
	4.1.1. Principle : Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). **4.1.2. Instrumentation**: NMR Spectrometer	
	4.2 ELECTRON SPIN RESONANCE SPECTROSCOPY	
	4.2.1. Principle: fundamental equation, g-value -dimensionless constant or electron g-factor, hyperfine splitting. **4.2.2. Instrumentation**: ESR spectrometer, ESR spectrum of hydrogen and deuterium.	8L

Note : Numericals and Word Problems are Expected from All Units

Reference Books :

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.

2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.

3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]

4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.

5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer

6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.

7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.

9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.

10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.

11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007.

12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.

13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011..

14. Chemical Kinetics,K. Laidler, Pearson Education India, 1987.

T.Y.B.Sc Physical Chemistry Practical

SEMESTER VI

PHYSICAL CHEMISTRY

COURSE CODE: USCHP02 **CREDITS: 02**

Non-Instrumental

Chemical Kinetics

To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant.

(No fractional order)

Viscosity

To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.

Instrumental

Potentiometry

To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate.

To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and cerric sulphate potentiometrically.

Conductometry

To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically.

Colorimetry

To estimate the amount of Fe(III) in the complex formation with salicylic acid by Static Method.

Reference books

1. Practical Physical Chemistry 3rd edition A.M.James and F.E. Prichard , Longman publication

2. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill

3. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House

4. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.

5. Experimental Physical Chemistry By V.D.Athawale.

6. Senior Practical Physical Chemistry By: B. D. Khosla, V. C. Garg and A. Gulati, R Chand and Co.. 2011

T Y B Sc Chemistry

Choice Based Credit System

SEMESTER V

Applied Component

(Drugs and Dyes)

COURSE CODE: USACDD501 CREDITS: 02 LECTURES: 60

Unit			Topics	
I	**1.1**		**General Introduction to Drugs**	**(8L)**
		1.1.1	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action),	
		1.1.2	Nomenclature of drugs: Generic name, Brand name, Systematic name	
		1.1.3	Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50},GI_{50} Therapeutic Index.	
		1.1.4	Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	1.2		**Routes of Drug Administration and Dosage Forms**	**(3L)**
		1.2.1	Oral and Parenteral routes with advantages and disadvantages.	
		1.2.2	Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets).	
	1.3		**Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.	
		1.3.1	**CNS Drugs:** Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. • Phenytoin (Hydantoin) • Trimethadione (Oxazolidinediones) (**Synthesis from acetone)** • Alprazolam (Benzodiazepines) • Levetiracetam (Pyrrolidines) • Amphetamine (Phenethylamine) (**Asymmetric synthesis from phenyl acetic acid)** • Chlorpromazine (Phenothiazines)	**(4L)**

UNIT-II (Drugs)

2	**2.1**		**Analgesics, Antipyretics and Anti-inflammatory Drugs.**	**(4L)**

		2.1.1	**Analgesics and Antipyretics** • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (**Synthesis from salicylic acid)** • Aspirin (Salicylates) • Paracetamol (p-Amino phenols)	

		2.1.2	**Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) **(Synthesis from 2,6-dichlorodiphenyl amine)**	
	2.2		**Antihistaminic Drugs**	**(2L)**
			• Diphenhydramine (Ethanol amines) • Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)** • Chlorpheniramine maleate (Ethyl amines) • Pantoprazole (Benzimidazoles)	
	2.3		**Cardiovascular drugs**	**(3L)**
			Classification based on pharmacological action • Isosorbide dinitrate (Nitrates) • Valsartan (Amino acids) (structure not expected) • Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)** • Amlodipine (Pyridines) • Frusemide /Furosemide (Sulfamoyl benzoic acid) • Rosuvastatin (Pyrimidine)	
	2.4		**Antidiabetic Agents**	**(2L)**
			General idea and types of diabetes; Insulin therapy • Glibenclamide (Sulphonyl ureas) • Metformin (Biguanides) • Dapagliflozin (Pyranose) • Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-ethylpyridin-2-yl) ethanol)**	
	2.5		**Antiparkinsonism Drugs**	**(2L)**
			Idea of Parkinson's disease. • Procyclidine hydrochloride (Pyrrolidines) • Ethopropazine hydrochloride (Phenothiiazines) • Levodopa (Amino acids) (**Synthesis from Vanillin)**	
	2.6		**Drugs for Respiratory System** General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives • Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines)	**(2L)**

			• Codeine Phosphate (Opiates)	

Reference Books: (For units I & II)

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.

Unit III (Dyes)

3	**3.1**		Introduction to the dye-stuff Industry	**(5L)**
		3.1.1	Dyes	
			Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries.	
		3.1.2	Natural and Synthetic Dyes	
			Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)	
	3.2		Substrates for Dyes : Types of fibres	**(3L)**
		3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.	
		3.2.2	Semi – synthetic: definition and examples [structures not expected]	
		3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them	
		3.2.4	Blended fabrics: definition and examples [structures not expected]	
		3.2.5	Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	
	3.3		Classification of dyes based on applications and dyeing methods	**(7L)**
		3.3.1	Dyeing methods	
			Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing	
			Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing	

		3.3.2	Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B,	
		3.3.3	Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	

Unit – IV (Dyes)

4	**4.1**		**Colour and Chemical Constitution of Dyes**	**(4L)**
		4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
		4.1.2	Relation between colour and chemical constitution.	
			(i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.	
	4.2		**Unit process and Dye Intermediates**	
		4.2.1	**A brief idea of Unit Processes**	**(3L)**
			Introduction to primaries and intermediates	
			Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)	

		4.2.2	**Preparation of the Following Intermediates**	**(8L)**
			Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG	
			Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS	
			Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	

References (For Units III & IV):

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

I] Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD5P1 **CREDITS: 02**

1. Estimation of Ibuprofen (back titration method)
2. Estimation of Acid neutralizing capacity of a drug
3. Preparation of Aspirin from salicylic acid.
4. Separation of components of natural pigments by paper chromatography (eg: chlorophyll)

II] Project:
Preparation of Orange II dye (semi-microscale1.0gms) and its use for dyeing different fabrics

SEMESTER VI

(Drugs and Dyes)

COURSE CODE: USACDD601 **CREDITS: 02** **LECTURES: 60**

UNIT – I (Drugs)

1	**1.1**		**Drug Discovery, Design and Development**	**(6L)**
		1.1.1	Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5	
		1.1.2	Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin)	
		1.1.3	Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides).	
		1.1.4	Structure modification to increase potency: Homologation, Chain branching and Extension of the structure.	
		1.1.5	Computer assisted drug design.	
	1.2		**Drug Metabolism:** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.	**(3L)**
	1.3		**Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
		1.3.1	**Antibiotics and antivirals:** Definition, • Amoxicillin (β- lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (**Synthesis from 2,3,4 – Trifluro -1-nitrobenzene)** • Aciclovir/Acyclovir (Purines)	**(2L)**
		5.3.2	**Antimalarials:** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether(Benzodioxepins) **Following combination to be discussed:**Atremether-Lumefantrine (no structure)	**(2L)**
		1.3.3	**Anthelmintics and AntiFungal agents** Drugs effective in the treatment of Nematodes and Cestodes infestations.	**(2L)**

			• Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2- Nitroaniline)** • Clotrimazole (Imidazole) • Fluconazole (Triazole) (**Synthesis from 1- Bromo – 2,4-difluorobenzene)**	

UNIT – II(Drugs)
Chemotherapeutic Agents continued.

2	**2.1**		**Antiamoebic Drugs** Types of Amoebiasis • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin-Tinidazole	**(1L)**
	2.2		**Antitubercular and Antileprotic Drugs** Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. • PAS (Amino salicylates) • Isoniazide (Hydrazides) • Pyrazinamide (Pyrazines) • (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1- Nitropropane)** • Dapsone(Sulphonamides) (**Synthesis from 4- Chloronitrobenzene)** • Clofazimine (Phenazines) • Bedaquiline (Quinoline) **Following combination therapy to be discussed:** (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide	**(3L)**
	2.3		**Anti-Neoplastic Drugs** Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants • Lomoustine (Nitrosoureas) • Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromo methyl) toluene)** • Cisplatin (Chloro Platinum) • Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected)	**(2L)**
	2.4		**Anti-HIV Drugs** Idea of HIV pathogenicity, Symptoms of AIDS • AZT/Zidovudine, Lamivudine,DDI (Purines)	**(1L)**
	2.5		**Drug Intermediates:** Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone	**(2L)**

			4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene	
	2.6		**Nano particles in Medicinal Chemistry** Introduction; Carbon nano particles (structures) and Carbon nano tubes: • Functionalization for Pharmaceutical applications • Targeted drug delivery • In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity.	**(4L)**
	2.7		**Drugs and Environmental Aspects** • Impact of Pharma-industry on environment, • International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".	**(2L)**

Reference Books (For Units I & II):

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.
11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
13. Nanoparticle and technology for drug delivery (Drugs and pharmaceutical sciences). Ram B.Gupta& Uday B.Kompella Pub. Informa Healthcare.
14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and Madhuri Sharon.MonadNanotechPvt. Ltd.
15. Environmental Chemistry. A. K. De
16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House,Pune.
17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. ltd.

Practical organic chemistry, Vogel.

SEMESTER VI

Unit – III (Dyes)

3	**3.1**		**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes** (Synthesis of the dyes marked with * is expected)	**(12L)**
			i)Nitro Dye: Naphthol Yellow S	
			ii) Nitroso Dye: Gambine Y	
			iii)Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
			iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
			v)Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid	
			vi)Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine	
			vii)Quinone Dyes: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
			viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
			ix) Phthalocyanine Dyes: Monastral Fast Blue B	
	3.2		**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**(3L)**
		3.2.1	**Impact of the textile and leather dye Industry on the environment** with special emphasis on water pollution	
		3.2.2	**Health Hazards:** Toxicity of dyes w.r.t food colours.	
		3.2.3	**Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	

Unit – IV (Dyes)

4	**4.1**		**Non-textile uses of dyes:**	**(8L)**
		4.1.1	**Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
		4.1.2	**Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits	
		4.1.3	**Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather	
		4.1.4	**Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
	4.2		**Pigments**	**(3L)**
			Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	
	4.3		**Dyestuff Industry - Indian Perspective**	**(4L)**
		4.3.1	Growth and development of the Indian Dyestuff Industry	
		4.3.2	Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India	
		4.3.3	Make in India - Future Prospects of the Dye Industry	

References (For Units III & IV)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry,Sodhi. G. S**.,** Alpha Science International, 2009
6. Planning Commission, Niti Aayog, FSSAI and FDA websites
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982

Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD6P1 **CREDITS: 02**

1. O-Methylation of β-naphthol.
2. Preparation of Paracetamol form p-aminophenol.
3. Preparation of Fluorescein
4. TLC of a mixture of dyes (safranine-T, Indigo carmine, methylene blue)

II] Preparation of monograph of any one drug from syllabus by I.P. method.

OR

Industrial visit Report.

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